MAY 25 1922

The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

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THE VIRGINIA OPOSSUM
HEREDITY DENIED BY BUDDHISTS
THE FRUTILLA OR CHILEAN STRAWBERRY
IMPROVEMENT OF SORGHUMS BY HYBRIDIZATION
POSITIONS AND MOVEMENTS OF COTTON LEAVES
BREEDING BLACKBERRIES AND RASPBERRIES
WHEAT RYE HYBRIDS IN RUSSIA

PUBLISHED MONTHLY AT MENASHA, WISCONSIN
BY THE
AMERICAN GENETIC ASSOCIATION
EDITORIAL AND GENERAL OFFICES
WASHINGTON, D. C.

Volume XII, Number 10 December, 1921

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The

Journal of Heredity

(Formerly the American Breeders' Magazine)

VOL. XII, NO. 10 DECEMBER, 1921

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The JOURNAL OF HEREDITY is published monthly by the
AMERICAN GENETIC ASSOCIATION
Publication office, 450 Ahnaip Street, Menasha, Wis.
Editorial and general offices, Washington, D. C.

Entered as second-class matter May 13, 1921, at the postoffice at Menasha, Wisconsin. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized Dec. 20, 1918. **Contents copyrighted 1921 by the American Genetic Association. Reproduction of articles or parts of articles permitted only upon request, for a proper purpose, and provided due credit is given to author and to the JOURNAL OF HEREDITY** (Organ of the American Genetic Association, Washington, D. C.), Menasha, Wisconsin. Address all communications to the Association's office at Washington, D. C.

Date of issue of this number, May 15, 1922.

A HYBRID BETWEEN FETERITA AND KAFIR CORN

In recent years the Office of Forage-Crop Investigations of the U. S. Department of Agriculture has undertaken the improvement of sorghums through hybridization. The above photograph shows a selected strain of a feterita-kafir hybrid in the seventh generation. The uniformity of development exhibited by these plants is noteworthy. The photograph was taken at Chillocothe, Texas, in 1920. (Frontispiece.)

IMPROVEMENT OF SORGHUMS BY HYBRIDIZATION

H. N. VINALL AND A. B. CRON[1]
Bureau of Plant Industry, U. S. Department of Agriculture

PAST work with sorghum hybrids in the United States has been limited very largely to the investigation and development of natural hybrids. The indifferent results attained in this way gave rise to the belief that there was little benefit to be derived from the hybridization of sorghums. Gradually the principal varieties have been purified and standardized by selection until their improvement in this way is about ended; at least the progress achieved by such methods is now extremely slow. Realization of this truth by those engaged in sorghum investigations has caused renewed interest in the possibility of improvement by hybridizing the best varieties.

Artificial hybridization of sorghums was begun by the Office of Forage-Crop Investigations of the United States Department of Agriculture in 1914 when the writers of this article made numerous crosses in the greenhouse at Washington, D. C., and in the field at Amarillo, Tex. Table I gives a list of these crosses.

Seeds from these sorghum crosses were sent to several Departmental field stations in the Great Plains in the spring of 1914 and the first generation grown that year. The second generation, grown in 1915, was studied carefully, but aside from being interesting genetically there was nothing very promising except from the crosses between feterita and milo and those between feterita and kafir.

TABLE I: ARTIFICIAL SORGHUM CROSSES

Pistillate parent	Pollen parent	Number of cross-fertilized seeds
Dakota Amber sorgo	Johnson grass	1
"	Blackhull kafir	42
"	Sumac sorgo	39
Gooseneck sorgo	Dakota Amber sorgo	7
"	Blackhull kafir	19
Honey sorgo	"	24
"	Gooseneck sorgo	12
"	Sumac sorgo	16
Sumac sorgo	Blackhull kafir	24
Blackhull kafir	Dwarf milo	2
"	Honey sorgo	2
Dwarf milo	Feterita	44
Feterita	Sumac sorgo	4
" *	Blackhull kafir	2
Blackhull kafir	Feterita	2
Red Amber sorgo	"	2
Feterita	Red Amber sorgo	2

* The last four crosses were made by A. B. Cron at Amarillo, Tex., in the summer of 1914. All the other crosses were made by the senior author in the early spring of 1914 at Washington, D. C.

FETERITA-KAFIR HYBRIDS

The crosses between these two varieties were made during the summer and fall of 1914 by the junior author at Amarillo, Tex. Contrary to our expectations the F_1 plants had panicles with brown seeds. In shape and compactness the panicles were practically intermediate between those of Blackhull kafir and feterita. In appearance the plants were more like the kafir parent than the feterita. They were somewhat taller and the stems were a little greater in diameter, but on the whole the resultant plants were about what one would expect except for the color of the seed. The seeds of both would ordinarily be described as white,

[1] Mr. Cron formerly in charge of forage investigations at the Amarillo Cereal Field Station, Amarillo, Tex., has been since 1918, Superintendent of Texas Substation No. 12, Chillicothe, Tex. The forage crop investigations at this point are carried on cooperatively by the Bureau of Plant Industry and the Texas Agricultural Experiment Station.

opment exhibited by these plants is noteworthy. The photograph was taken at Chillocothe, Texas, in 1920. (Frontispiece.)

although kafir seeds are specked with brown and the seeds of feterita are often marked with brown beneath the glumes. It is usually thought that the brown color on feterita seeds arises from a discoloration of the seed by its contact with the glume or hull. There may, however, be some color in the seed itself.

Segregation in the F_2 generation showed many widely diverse types from dwarfs about two feet tall to plants over six feet tall; the population varied also in leafiness, shape, and compactness of the panicle, size and color of the seeds, juiciness and sweetness of the stems, and many other characters. The several types selected for further trial were intermediate in most characters to the two parents resembling in many ways Dwarf hegari. (See Fig. 1.) In Table II is given in parallel columns a comparison of the F_7 of one of these hybrids with its two parents. Most of the types selected for increase and plat trials have bred true from the third generation. (Frontispiece.)

The general practice which is now being followed in testing these hybrids at Chillicothe, Tex., is as follows:

First generation.—The cross-pollinated seeds are planted in rows and all the heads of the F_1 plants are bagged to prevent cross-pollination.

Second generation.—All the seeds produced by the F_1 plants are sown in rows. As these F_2 plants mature selections representing the most promising types are made and the heads bagged for continued testing in comparison with the parents and other commercial varieties.

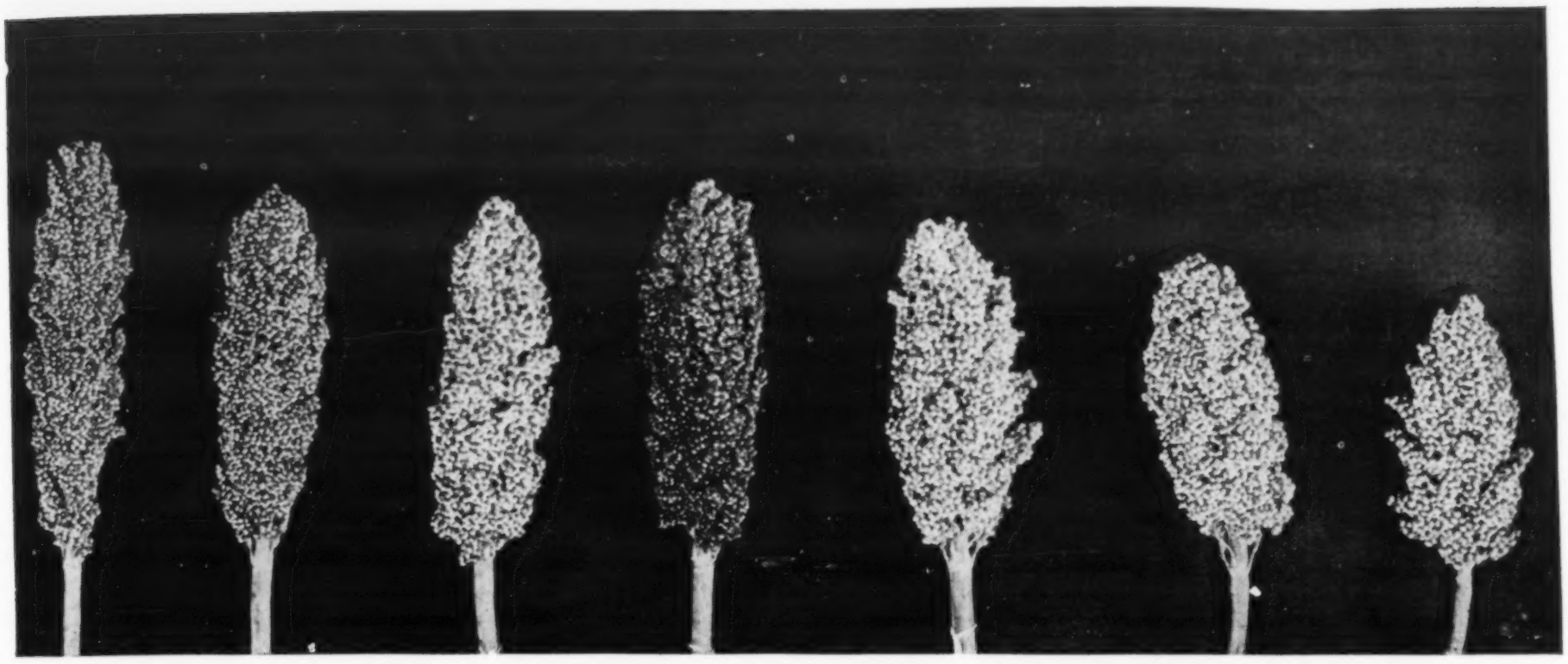
Third generation.—Head to row seedings of the F_2 selections are made, each row being duplicated at least three times with rows of the parent varieties included as checks. From the rows of hybrids, selections are made of the best plants and the heads bagged. If some rows appear to be particularly promising a sufficient number of heads are bagged so that a plat test of such strains can be made the following year. The other selections made are continued in row tests. In the third generation the row is judged as a unit if it shows decided uniformity in its general characters.

Fourth generation.—The most promising strains from the F_3 rows are seeded in duplicate plats which are protected from cross-pollination with other sorghum varieties by surrounding the plat with rows of some tall growing corn

TABLE II: COMPARISON OF A SEVENTH GENERATION SELECTED HYBRID WITH THE PARENT TYPES

PLANT CHARACTERS	♀ FETERITA (See Fig. 2)	F_7 HYBRID (See Fig. 1)	♂ KAFIR (See Fig. 3)
General uniformity	96	98	98
Height, inches	54–60	42–48	44–48
Diameter of stem, inches	½–⅝	⅝–¾	¾–⅞
Juiciness of stem	slight	medium-slight	medium
Sweetness of stem	slight	medium-slight	none
Branches of stem	few	none	none
Number of leaves	10	12–14	12–14
Color of leaves	medium green	dark green	dark green
Width of leaves	medium	broad	broad
Length of leaves	medium	medium	medium
Leaf sheath overlapping	none	much	much
Position of panicle	erect or slightly inclined	erect	erect
Shape of panicle	ovoid	ellipsoid	cylindrical
Exsertion of panicle	fully*	only ⅞	fully
Size of seed	large	intermediate	small
Color of seed	white	white	white
Hardness of seed	soft	intermediate	hard
Color of glumes	black	black	black
Growing season, days	90	92	95

* Exsertion of the head in feterita is often due to the bending of the peduncle away from the leaf sheath as in milo rather than extension beyond the leaf sheath.



HEADS OF FETERITA, KAFIR, AND HYBRIDS

This illustration shows two sorghums which have been used in making hybrids, and some of the resulting forms: on the extreme right is a head of feterita, and on the extreme left one of kafir; the five heads between them represent strains which have been selected from crosses between the two, and which are now being used in the work of developing forms desirable for extensive cultivation. (Fig. 1.)

(Fig. 4). In these plats the yield of grain and forage is the basis of final judgment as to the value of any particular strain. The other selections from F_3 plants are grown in head-to-row seedings as in the former year and if none of these selections now seem to be more valuable than the strains in the plat tests they are all discarded. Usually however one or two additional selections are found which appear worthy of plat tests.

Fifth generation.—The best strains as shown by the F_4 plat tests are grown in larger areas to increase the amount of seed if comparison with the parent varieties indicates that any of these strains are superior to the standard commercial varieties. Plant selection is continued in the other strains.

The hybrid described in Table II is a selected strain which is being grown as F. C. I. 8921. It has been produced under the selection system just described. The yields of this strain and two other feterita-kafir hybrids on the experiment station at Chillicothe, Tex., for the year 1921 are given in Table III

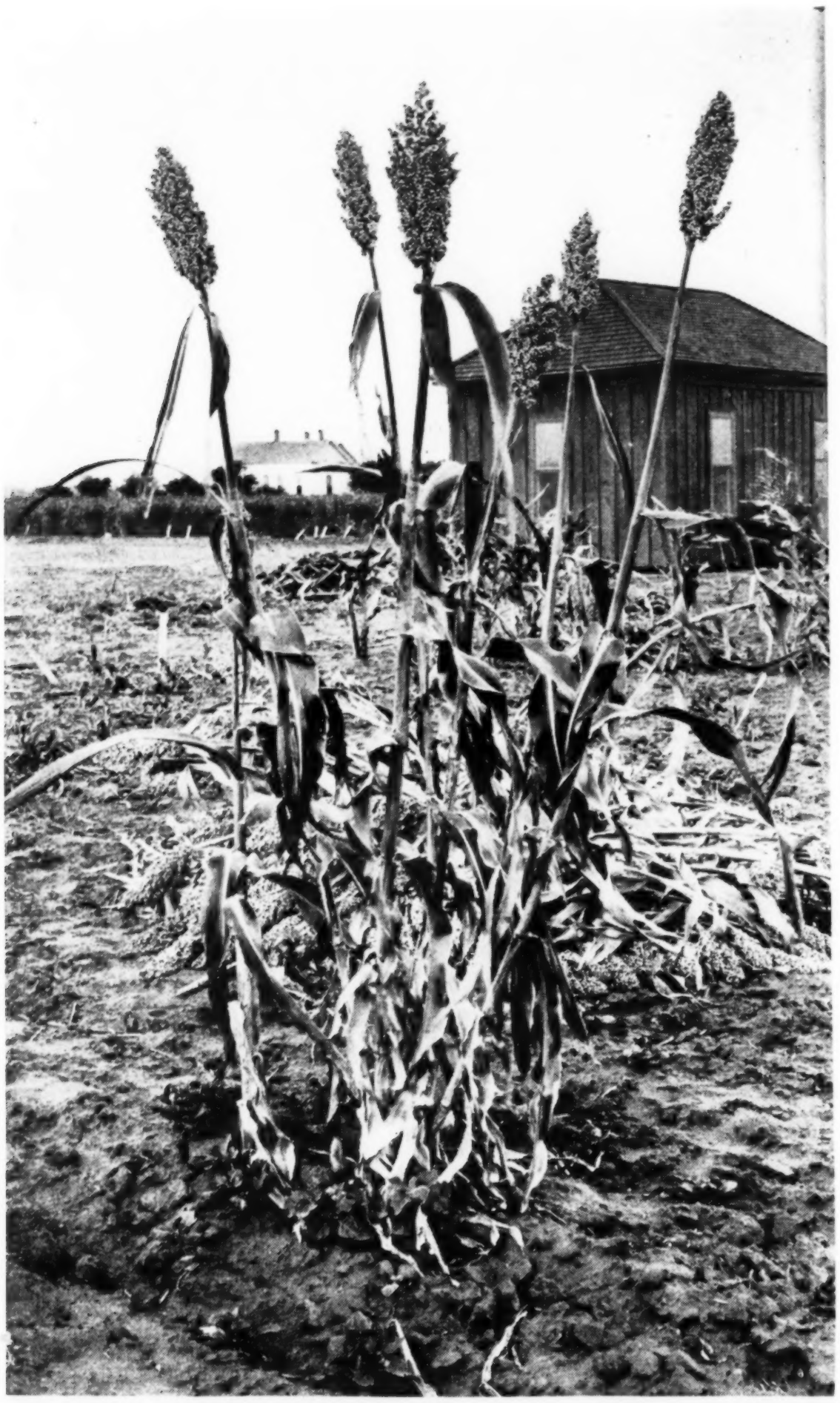
INHERITANCE OF CHARACTERS IN THE SORGHUMS

In connection with the improvement work genetic studies were made of the feterita-kafir and several other crosses. Lack of time and the feeling that the production of an improved strain was

TABLE III: GRAIN AND FORAGE YIELDS OF FETERITA AND KAFIR IN COMPARISON WITH THE YIELDS OF THREE HYBRIDS OF THESE VARIETIES

Serial No.	Variety	Air-dry forage yields per acre		Grain yields per acre		Relative yields of forage	Relative yields of grain
		1920	1921*	1920	1921	Ave. 1920-21	Ave. 1920-21
		Tons.	*Tons.*	*Bushels*	*Bushels*	*Per cent.*	*Per cent.*
811	feterita	2.24	1.32	31.4	21.0	97	104
8917	feterita X kafir	1.18	.90	34.3	29.2	57	127
8921	"	2.52	1.34	33.9	30.0	105	128
8929	"		1.53		29.7		
24983	Dwarf kafir	2.35	1.33	30.1	19.9	100	100

* Both grain and forage yields were rather low at Chillicothe, Tex., in 1921 on account of the poor distribution of seasonal rainfall. The stands and soil conditions, however, were alike, hence the yields are comparable.



A FETERITA PLANT

One of the plants used by the writers in the production of new sorghums is feterita, of which a mature plant is shown above. From this picture, a clear idea of the leaf, stem, and head characters of this crop can be obtained; it should be compared with the plant of Blackhull kafir, shown on the opposite page, since the latter was the other parent of many of the crosses discussed in the present paper. (Fig. 2.)

the real object to be kept in mind prevented a more comprehensive genetic survey of the very interesting and abundant material. However, the manner in which several minor characters were inherited was determined.

INHERITANCE OF SEED COLOR

Feterita X Red Amber Sorgo

The seed of feterita is bluish-white with limited areas of brown on some seeds. This color seems to arise from discoloration of the seed by contact with the black glume. Red Amber sorgo has seeds which are uniformly red-brown and this is dominant over the feterita seed color. The F_1 seeds are all red-brown like those of the Red Amber sorgo (Fig. 5). On the F_2 plants the segregation indicates that two independent unit factors are involved in the determination of the seed color. These two factors may be designated *R* (red) and *B* (brown).

The suggested formula for the two parents of the cross are, for feterita rrbb and for Red Amber sorgo RRBB. F_1 would therefore be RrBb with red-brown seed like those of Red Amber and F_2 would segregate into 9R-B- with red-brown seed like the Red Amber sorgo; 3 R-bb, plants with seed having only the red color; 3 rrB-, plants with seed having only the brown color on a white background; and 1 rrbb, plants with white seed like feterita.

The progenies of several crosses between feterita and Red Amber sorgo which were classified during the winter of 1916–17 conformed quite well with the two factor hypothesis giving a good 9 : 3 : 3 : 1 ratio. The results of this classification are given in Table IV.

Unfortunately some other progeny material of crosses between these same varieties classified later, gave results that are not in accord with the results in Table IV. There was a 3 : 1 ratio between red (red-brown and red) and not red (brown and white), the actual percentages being 75.9 per cent to 24.1 per cent. Separated, however, on the basis of brown and not brown, there was an excess of brown actually 80.2 per cent of this class. The difficulty seems to have been in the separation of the red-brown and reds, there

BLACKHULL KAFIR

Crosses between Blackhull kafir, of which a characteristic stem is shown above, and feterita, have given rise to new forms which have been selected to the seventh generation. The F_1 plants produced seed-panicles practically intermediate between the two parents in character, but in general appearance the plants more closely resembled kafir. (Fig. 3.)

A FETERITA—MILO HYBRID

In addition to the feterita-kafir crosses described in the present paper, the writers have hybridized feterita and milo. The above picture shows a selected strain of the feterita-milo cross, growing between rows of corn or maize to prevent contamination with nearby sorghums. The plants are noteworthy for their uniform size. (Fig. 4.)

TABLE IV: SEGREGATION OF SEED COLOR IN THE F_2 PROGENY OF CROSSES BETWEEN FETERITA AND RED AMBER SORGO

	Seed Color					P from 9:3:3:1
	Red-brown	Red	Brown	White	Total	
Feterita X Red Amber 8873–1–2	1246	425	430	141	2242	.3
Feterita X Red Amber 8873–1–3						
Feterita X Red Amber 8873–1–4						
Feterita X Red Amber 8873–1–5						
Feterita X Red Amber 8878–1–4	587	178	191	92	1048	.006
Red Amber X Feterita 8882–2–1	432	155	147	45	779	.74
Red Amber X Feterita 8882–2–2						
Totals observed	2265	758	768	278	4069	.46
Totals calculated	2289	763	763	254	4069	
Percentages observed	55.7	18.6	18.9	6.8	100	
Percentages calculated	56.25	18.75	18.75	6.25	100	

being a large excess of the former. There was also an excess of whites. Other material from crosses of these two varieties will have to be analyzed to fully establish the value of this hypothesis in regard to the inheritance of the seed color.

FETERITA X KAFIR AND KAFIR X FETERITA

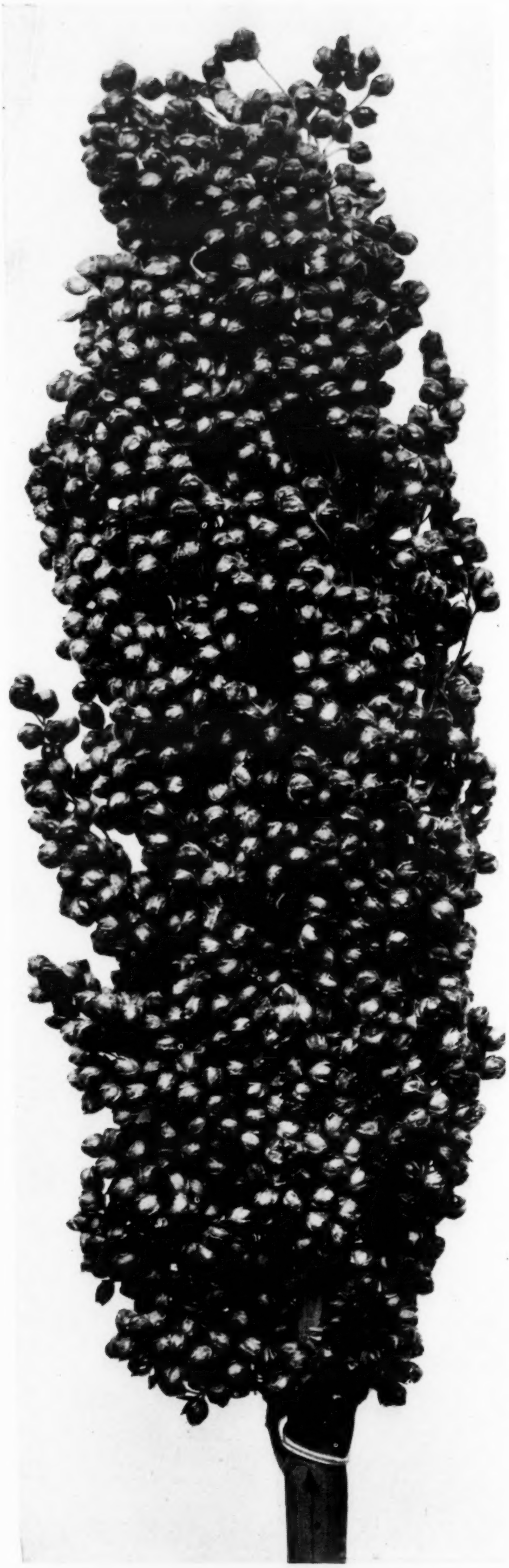
In studying the seed color in crosses between feterita and kafir it was apparent that here also two factors were concerned in the production of color. They did not prove, however, to be the same two that determined color in the Red Amber sorgo seed since the red color was not present in the progeny of the feterita-kafir crosses. The most plausible explanation is that the Blackhull kafir carries the factor *B* for brown color, but not the *R* for red and that feterita seed carries a factor *S* affecting color, but acting as a spreader of the brown pigment which is manifested

TABLE V: SEGREGATION OF SEED COLOR IN THE F_2 PROGENY OF CROSSES BETWEEN FETERITA AND BLACKHULL KAFIR

Serial No.	Name of Cross	Plants with		Per cent white	$\frac{D}{E}$
		brown seeds	white seeds		
8877–2–1	feterita X kafir	252	205	44.8±1.56	.67
8877–2–2	"	309	255	45.2±1.40	1.03
8880–8–1	kafir X feterita	179	79	30.6±2.08	6.30
8880–8–2	"	355	236	40.0±1.37	2.70
8880–8–3	"	224	133	37.3±1.77	3.60
8881–13–1	"	216	246	53.3±1.55	6.20
8881–13–2	"	135	122	47.4±2.08	1.70
Totals	"	1670	1276	43.4± .62	.56

TABLE VI: SEGREGATION OF F_2 PROGENY ACCORDING TO COLOR OF GLUMES

Glume Color	8882–7–1	8882–7–2	8882–7–3	8883–4–1	8883–4–2	8883–4–3	Totals observed	Per Cent	$\frac{D}{E}$
Red	542	226	509	547	575	436	2835	75.9±4.8	.19
Black	169	79	172	146	190	134	890	24.1±4.8	.19



in the kafir seeds only as small splotches or specks of red-brown. The genetic formula for the two sorghums would then be as follows: For feterita SSbb and for kafir ssBB.

If these factors acted independently F_1 would be SsBb, brown seeded with the brown color diffused or spread over the seed coat by the combination of the pigment factor *B* with the spreading factor *S*. This conforms to the results obtained since all the seed in the F_1 was uniformly brown with the color spread evenly over the seeds, most prominent on the outer or blossom end, but not collected in splotches or specks as it is in kafir. (Fig. 6.) F_2 according to the above theory would segregate into 9S-B-, 3S-bb, 3ssB- and 1ssbb. The S-B- representing 56.25 per cent of the total would be brown seeded like the F_1 seed; the S-bb would be white like feterita, the ssB- would be white like kafir with only brown specks, and the ssbb would also be white lacking both the factor for brown pigment and also the *S* factor. These last three phenotypes all being white make up 43.75 per cent of the total number.

The results obtained conform in the main very closely to this interpretation and are given in Table V.

INHERITANCE OF COLOR IN THE GLUMES

Red Amber Sorgo X Feterita

Red Amber sorgo has uniformly dark red glumes, while feterita has black glumes. In several crosses where the sorgo was used as the pistillate parent, it was found that the red in the glumes was dominant over the black. The results from

A SORGO-FETERITA CROSS

Above is shown a single head from an F_1 plant of the cross between Red Amber sorgo and feterita. It will be noted that the head is quite compact in form. The glumes are red, like those of the sorgo parent. (Fig. 5.)

the different crosses between these two sorghums were as follows: F_1 was uniformly red glumed like the Red Amber sorgo and F_2 segregated as shown in Table VI, indicating that there is but a single factor difference between red and black glumes.

INHERITANCE OF THE AWN

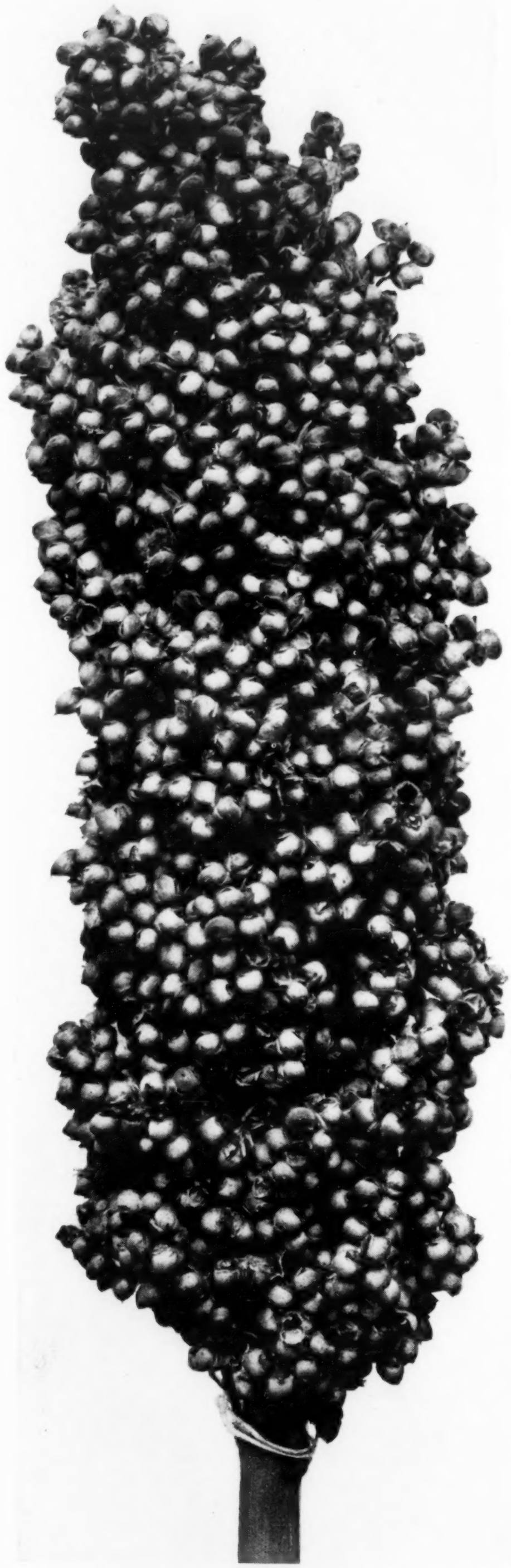
Dwarf Milo X Feterita

In milo the glumes are awned while in feterita they are not awned. In crosses between Dwarf milo and feterita it was found that the awn was a recessive character. In F_1 the seeds were unawned and in F_2 there were 183 plants with unawned seed to 68 that had awned seed. The calculated number of segregates would be 188 : 63 which approaches very closely the actual numbers obtained from the crosses. It would seem, therefore, that the awn in sorghums is a recessive character as it is in most of the small grains.

INHERITANCE OF SHAPE IN THE GLUME

Dwarf Milo X Feterita

Milo has a broad truncated glume which maintains an appressed position at the outer tip. Feterita glumes on the other hand are ovate with a rather acute tip which tends to become somewhat involute at maturity and bend away from the seed at the outer end. The progeny of the cross between Dwarf milo and feterita showed the broad truncated shape to be dominant over the narrower ovate shape of the feterita glumes. An analysis of the F_1 progeny showed that 187 plants had the truncated glumes, while 64 had the narrow ovate glumes. The calculated ratio would be 188 : 63.



A FETERITA-KAFIR CROSS

In shape and general characters this head, which was taken from an F_1 plant of the cross between feterita and kafir, resembles the feterita parent, but the seeds are light brown instead of white. (Fig. 6.)

POSITIONS AND MOVEMENTS OF COTTON LEAVES

How the Leaves Adjust Their Position to Varying Conditions of Illumination and of Soil Moisture

R. M. MEADE[1]

THE leaves of the cotton plant are capable of definite movements which are made in direct reaction to sunlight. The movements of the leaves are governed by the pulvini in the blade and petiole, similar to those that determine movements in other plants. While the results here reported are of observations on plants of *Gossypium hirsutum* (Upland cotton) it has been observed that similar reactions occur in different degrees in other species of Gossypium.

SIZE AND SHAPE OF THE COTTON LEAF

The leaves of cotton seedlings are entire, but as the plant grows older there is a gradual change in leaf shape until the final leaves of the mature plants are deeply cleft with three to seven palmate lobes. The blades are nearly equal in length and width and vary from three to six inches in each dimension, with the petiole or stem about as long as the blade. The main veins are very prominent, especially on the lower surface of the leaf, and radiate from the junction of the blade with the petiole, extending to the tips of each lobe.

LOCATION, STRUCTURE AND FUNCTION OF THE TWO ORGANS WHICH CONTROL LEAF MOVEMENTS

The movements of the leaves in response to light are controlled by two organs located on the petiole of the leaf. These organs are the *basal pulvinus*, situated at the base of the petiole, and the *distal pulvinus*, at the end of the petiole.

The basal pulvinus, visible externally as a thickening of the base of the petiole, (See Fig. 7) differs structurally from the rest of the petiole in having less pith, more compact fibro-vascular bundles, and more fleshy tissue surrounding the bundles. Frequently the pulvinoid tissue attains an inch and a half in length and a diameter twice that of the rest of the petiole. Often there is no definite distinction between the pulvinus and the petiole proper, as the pulvinus tapers gradually to the diameter of the rest of the petiole. Sometimes, however, the change in size is more abrupt and distinctly marked. The function of this pulvinus appears to be that of controlling the movement of the petiole.

The distal pulvinus is composed of the upper part of the petiole ending with a callus or cushion at the junction of the principal veins of the leaf. The pulvinoid tissue of the upper portion of the petiole is generally not more than half an inch long and scarcely thicker than the middle of the petiole. A special feature of the distal pulvinus is at its attachment to the blade where it is contracted, leaving very little tissue around the bundles of the stem. The constricted portion acts as a pivot on which the blade may swing without greatly altering the position of the petiole.

The veins may be distinctly thickened for a distance of three-fourths of an inch from the base, and distin-

[1] All characters, whether morphological or physiological, of an important cultivated plant like cotton are of interest to breeders. Little has been done in comparing related species and varieties of plants in regard to their physiological characters and almost nothing is known of the inheritance of such characters, except as regards resistance to diseases. An interesting subject for investigation in this difficult field is suggested in this paper which is based upon a manuscript found among the papers of the late R. M. Meade.—R. D. Martin.

guished, like the callus, by a reddish color. The callus and thickened bases of the veins have a function in shifting the individual lobes, and may act independently to a certain extent, although generally functioning together so as to cause the blade to face the direct light.

INDEPENDENT AND SIMULTANEOUS ACTION OF THE TWO PULVINI WHICH ADJUST THE LEAF BLADE IN CHANGES IN DIRECT ILLUMINATION

The leaves of the cotton plant are heliotropic, that is, the blades move in such a way as to keep the upper surface perpendicular to the direct rays of light. The leaves gradually shift their positions as the direction of the light changes, leaves that are differently situated on the plant moving in different directions. The changes in position are governed by the pulvini, as already noted.

Both governing organs may function at the same time or each may act independently. The distal pulvinus may raise or lower individual lobes of the blade, or shift the whole blade while the basal pulvinus alters the position of the whole leaf. Under direct light the leaves are in constant but gradual motion. Thus the leaves are in a different position in the afternoon than in the morning, the blades facing east in the forenoon and west in the afternoon.

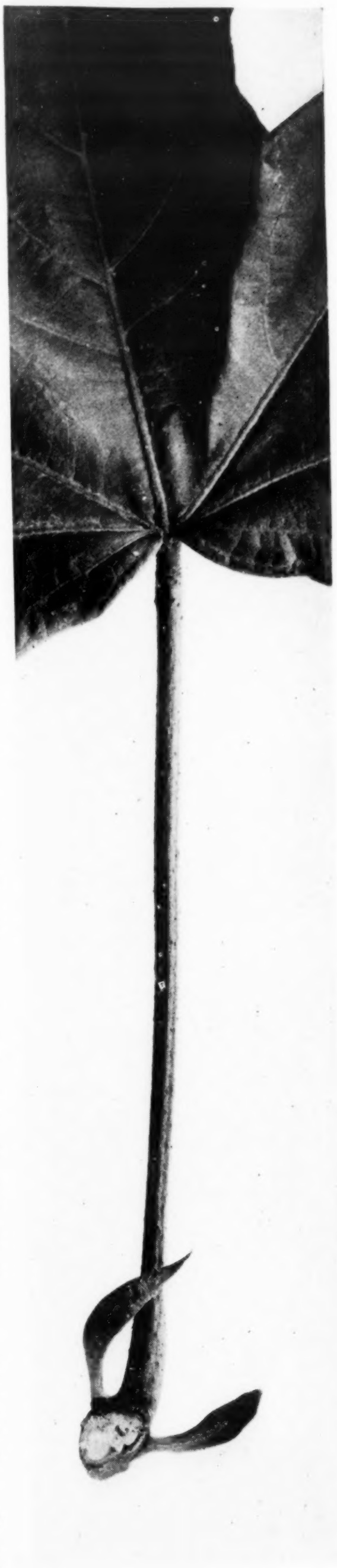
Movements are most varied on the side of the plants away from the direct light, where many of the leaves are in the shade. Here a single leaf usually requires the aid of both the distal and basal pulvini to adjust the blade and petiole. Some turn to the right and some to the left while others either rise or fall, according to the exposure to the strongest light. The blade or the petiole may take almost any position, the blades always moving to face the direct light. Often the blade extends straight out from the petiole, or is forced against the petiole on the under side. The petiole may take either an acute or an obtuse angle to the perpendicular.

POSITION OF LEAVES UNDER DIFFUSED LIGHT

In the diffused light of cloudy weather the leaves show practically no movement or differences in position and for this reason the position of the leaves common under diffused light is considered the typical day position. Under such conditions, regardless of the angle of the stems on which they are borne, the petioles stand at an angle of about 45 degrees from the vertical and the leaf-blade is usually flat, but on plants with large leaves they are somewhat folded at the sinuses.

NIGHT POSITION OF LEAVES DISTINCT FROM THAT ASSUMED DURING DAY

The leaves take a position at night



Petiole of a cotton leaf to indicate location of distal and basal pulvini. (Fig. 7.)

POSITION OF COTTON LEAVES AT NIGHT

The leaves of the cotton plant perform definite movements in reaction to light. These movements are controlled by two organs located on the petiole of the leaf: one, the pulvinus at the base of the petiole, and the other, the pulvinus at the distal or outer end of the same. The above photograph shows the position which the leaves assume at night: though they have the appearance of being wilted, the turgidity is actually greater than it is when the leaves are in the day position. (Fig. 8.)

A COTTON PLANT IN ITS DAY POSITION UNDER DIRECT LIGHT

This is the same plant as the one shown on the opposite page. The leaves are constantly adjusting their positions according to the directness of the sun's rays. The distal pulvinus located in the end of the petiole raises or lowers individual lobes of the leaf-blade, and the basal pulvinus changes the position of the whole leaf. "The leaves are in a different position in the afternoon than in the morning, the blades facing east in the forenoon and west in the afternoon." (Fig. 9.)

which is different from any position assumed in the daytime. (See Fig. 8.) At night the blades fall to a vertical position, the petiole remaining in the position common under diffused light except that the distal end bends slightly downward. The tissue of the blade between the primary veins folds a little outward and the tips of the lobes come closer together. The tips of the lobes may curl slightly toward the petiole, especially if the night temperature is considerably lower than that of the day. This night position is similar to that assumed by leaves that have become wilted, except that severely wilted leaves fold the lobes even closer together. The great difference is the condition of the tissue; at night the leaf is in a state of turgidity even greater than at any time during the day, while the wilted leaves are flaccid.

Under the influence of intense light acting for a considerable time, the leaves of the cotton plant often wilt or lose their turgor. The blade falls to a vertical position, with lobes deeply grooved or folded. The wilted condition is similar to that of a leaf that has been separated from the plant and is suffering for want of moisture. When in this condition transpiration is apparently checked and the leaf is in a state of rest.

Ordinarily only the *distal* pulvinus is affected when the leaves wilt. The upper part of the petiole curves downward and the blade remains in a drooping position until the light diminishes or a new supply of moisture is obtained. In some cases, however, the whole petiole becomes limp and falls with the rest of the leaf, though this seldom happens unless the light remains intense for a considerable length of time and the soil moisture is nearly exhausted. When a plant becomes wilted in this manner it is generally affected to such an extent that the leaves may never recover.

If light becomes less intense before sundown on account of cloudiness or for any other reason and a supply of moisture can be obtained from the soil, the tissue again fills with water and becomes turgid. The leaf then returns to the typical day position common under light conditions. (See Fig. 9.) After sundown the leaf gradually droops to the night position. When the light has continued intense throughout the day and the leaves have remained in the wilted state until nightfall, they retain the same relative position in the dark but soon become turgid.

The Delinquency of Women

A Study of Women Delinquents in New York State, by Mabel R. Fernald, Mary H. S. Hayes, and Almena Dawley, with a statistical chapter by Beardsley Ruml and a preface by Katherine Bement Davis. Pp. 542, with 225 tables and 46 charts. The Century Co., New York, 1920.

This study of 102 commitments at the state reformatory, Bedford Hills, N. Y., and comparable numbers from five other sources, is the most careful and detailed piece of work that has been done on the subject. The hereditary aspects are perhaps handled less satisfactorily than any others, such traits as alcoholism, suicide, criminal record, psychopathic condition, sexual irregularity, tuberculosis, venereal diseases and nomadism being thrown in together under this heading. More attention was paid to the social and educational background, and to the mental status of the offender. A cautious summary concludes that inferior economic background and somewhat inferior mentality are particularly characteristic of the women delinquents studied; all of which connotes poor home conditions, inadequate education, and industrial inefficiency. Further investigation might have shown that all these characteristics belong to a germinally inferior stock. Table 75, purporting to show that first-born children are in excess among delinquents, is based on an elementary statistical fallacy, ignoring the fact that there are inevitably more first-born children than any other kind in the whole population. But despite minor defects the volume remains a worthy monument to the Bureau of Social Hygiene, and an indispensable work of reference to those interested in delinquency.—P. P.

BREEDING WORK WITH BLACKBERRIES AND RASPBERRIES

H. NESS
Horticulturist, Texas Agricultural Experiment Station

OUR work with the genus Rubus, which has for its object the improvement of our cultivated blackberries and dewberries, was transmitted to me by my predecessor as Horticulturist to the Texas Experiment Station. The materials on hand in 1909, when I took charge, consisted of about a dozen varieties of blackberries and dewberries most commonly cultivated in our region. To these I added a few varieties of raspberries for the sake of pollen. As fruit bearers, raspberries are not dependable upon our grounds.

In looking the material over, I decided to begin the work by crossing those forms that showed the most opposed differences in characters, hoping thereby that the elements in the composition of the progeny might be more easily recognized and studied. As a second part of the project, I decided to grow as many seedlings from each variety as possible with a view to studying their variation and the opportunity for selection.

ORIGIN OF SPINELESS BLACKBERRIES

From the McDonald Blackberry, a native of Texas, introduced into cultivation by the Texas Nursery Company, 2,000 seedlings were brought into bearing. This variety has a diffuse, spiny growth, and is supposed to be a natural hybrid. The 2,000 seedlings fell readily into several more or less distinct groups, one of which was marked by its firm, almost coriaceous, smooth, lustrous leaves of 3 to 5 ovate-lanceolate, nearly entire-margined leaflets. In this group, two plants occurred with perfectly smooth shoots, as free from spines as an ordinary blade of grass. According to the general habit of growth of these two plants, I designated them, one as Spineless-diffuse, the other as Spineless-erect. From the Spineless-diffuse, I have grown four generations of seedlings; and, though cross-pollination with other forms was provided against in the first generation only, the majority of the progeny in each generation comes spineless and remarkably true to the spineless type in all other characters. My notes on the characters of the fourth generation give the following grouping of 200 young plants: 81 perfectly smooth, with all characters of the original type; 59 not smooth, with spines more or less evident, but otherwise typical; 60 plants not smooth, and of a different type.

The plants of the spineless group are readily recognized when very small by the form of the first leaf, which is cordate or cordate-lanceolate with entire or crenulate margins. The shape of these leaves is so similar to certain types of violets that they might, when young, be passed off on the unsuspecting as violets.

In crossing the Spineless-erect with the Early Harvest, two plants were obtained. The spineless form in one of these was so dominant that no traces of the Early Harvest, the mother, could be detected. This spineless F_1 selfed gave 77 individuals, in which the spineless grandfather was dominant, and 130, in which the Early Harvest, or the grandmother, was dominant. None were absolutely smooth, that is, without pubescence, as in the true spineless type, but the form of the first leaf of the 77 plants was true to that type.

EARLY HARVEST X AUSTIN MAYES

My first attempts at hybridization were, however, directed towards the combination of two forms that I

considered very suitable for my purposes, and from which I hoped for economic results of importance. These were the Early Harvest blackberry and the Austin dewberry.

The Early Harvest, assigned by systematists to *Rubus floridus*, has erect, fluted canes with few spines, tri-pinnate leaves, compact and elongated flower clusters with short bracteolate pedicels, and small flowers. The fruit also is small, but one of the sweetest, and the seed the smallest of any of the cultivated blackberries.

The Mayes dewberry, also called the Mayes Hybrid Austin and Austin-Mayes, referred to *R. baileyanus* x *floridus*, has a prostrate, diffusely branching growth with terete canes covered with a few rather small, straight spines. The leaves are 3 to 5 foliate; the flowers large, on elongated pedicels in loose, flattopped, bractless clusters. The fruit is large, composed of a few but large drupelets with very large seeds; the flavor is quite sour, and the aroma not perceptible.

From a cross between these two forms, Mayes being the mother, I grew to fruiting an F_1 generation of 28 plants. The characters of Mayes were so strongly dominant in all of them, as almost to exclude all traces of the other parent. All of these plants flowered profusely, and some produced many fruits which, however, were more or less imperfect and irregular in form, due to two kinds of drupelets, small and large intermixed, this being the most evident character of their hybrid origin.

An individual, in which the characters from both parents were more eivdent than in the rest, was screened off from foreign pollination. From the seed of this, an F_2 generation of 425 plants was raised. Of these, 367 had the characteristics of Mayes, 37 might be classed as intermediate, and in 21 the characters of Early Harvest were predominant. Two of the most typical of the last named group were screened. They flowered profusely but set no fruit. All other plants of that same generation, exposed to foreign pollen, were more or less sterile, or set imperfect and inferior fruit.

From the reciprocal cross, with Early Harvest as the mother and Mayes as the pollen parent, I failed to obtain any progeny; nor did I succeed any better with it as mother, using pollen from other sources.—The flowers of Early Harvest are strictly self-fertile and, generally, self-fertilized. —What bearing that fact may have on the difficulty of effecting a cross, I do not know.

For some years, I made numerous attempts to obtain crosses between various forms of our cultivated blackberries and dewberries, and failures resulted either from perfect or partial sterility; or the hybrids disgusted me, because of their confused characters as well as their utter failure to give any promise of improvement for economic purposes. In fact, they all bore the stamp of degenerates in that respect. I will only mention one of these cases, namely, a cross between the Mammoth blackberry and the Dallas blackberry.

THE MAMMOTH X DALLAS CROSS

The first generation of this cross consisted of 11 plants, with the vegetative organs uniformly intermediate between the parents. In the flowers, the following anomalies were noticeable: the stamens were much reduced in number and their filaments in length; the disk, upon which the stamens were inserted, had developed into a ring of papilla-like swellings bearing fascicles of pistils replacing a goodly number of the stamens. Such stamens as developed were, however, fertile to a considerable degree, since under screen fairly well developed fruits were obtained. In the second generation, this anomaly in the flowers increased, especially in those where the Mammoth characters were dominant. In some, the stamens had vanished altogether, and the accessory pistils had become perfect and fertile, developing drupelets of normal appearance when pollenized with pollen from the Logan blackberry (loganberry).

A CROSS BETWEEN THE LOUISIANA DEWBERRY AND THE BRILLIANT RED RASPBERRY

The plants which resulted from the cross between the Louisiana dewberry (*Rubus rubrisetus*) and the Brilliant Red Raspberry (*R. strigosus*) resembled the latter much more closely than the former. Some of them produced fruit of larger size than that of either parent. The field shown above contains seedlings of the F_3 generation. (Fig. 10.)

SEEDLINGS OF THE MCDONALD BLACKBERRY

The McDonald Blackberry is supposed to be a natural hybrid. It is diffuse and spiny in growth. Two thousand seedlings of this berry were grown, and they were found to vary considerably in character. They were classified in two general groups, one called Spineless diffuse, the other Spineless-erect. The young plants shown above are descendants of the Spineless-diffuse type (F_4 from the original stock of the McDonald). The plants on the left are spineless in character; those on the right, spiny. (Fig. 11.)

From this peculiar fruit, I obtained thirty-nine plants, in which all but one showed the characters of the Logan in their early youth; but as they were all lost during the first summer, I missed in this, as in many other cases, the opportunity to study them further.

SUCCESSFUL RASPBERRY-BLACKBERRY HYBRIDIZING

I had up to this time made frequent attempts to cross the blackberries or dewberries with various varieties of the raspberries, but without success, until I made use of seedlings of *Rubus rubrisetus* (Rydb.) as pistil plant.

A quart of fruit of this species was obtained from southern Louisiana in 1910. The seed was sown the same fall and gave rise to a large number of plants, quite uniform in general appearance. In 1913, a goodly number of flowers on various individuals of these seedlings were pollenized with the pollen from the Brilliant and Loudon, red raspberries. From this first combination with the *R. rubrisetus* as mother, which for short I shall call the Louisiana dewberry, or still more briefly the Louisiana, I raised twenty-one plants to be transplanted into the open field, and from the other cross with the same mother and Loudon as father, a few less.

The characters of the raspberry, *Rubus strigosus*, were strictly dominant in all the individuals of each lot, nor was there any discernible difference in the appearance of the two lots. In both, the plants were about equally infertile, though nearly all flowered at the proper season. The flowers varied somewhat in size on the various plants, the smallest being slightly larger than the raspberry, and the largest slightly smaller than the Louisiana berry. Whatever fruit set consisted of a few drupelets, irregularly distributed on the receptacle. The color was dark-red to almost brownish-black, when dead-ripe. Cross pollination was attempted between the various individuals, but did not result in more fruit.

For two years in succession, 1913 and 1914, the seeds were sown and a small number of plants as a second generation were raised each year; but no individual appeared more fertile, or more promising than those of the first generation. In 1915, the crop of fruit from this first generation was a little more abundant and gave rise to 280 plants, of which 125 reached bearing age in 1917. But, as the mother plants of the first generation were not screened from foreign pollination during flowering that spring, the true parentage of these plants was in doubt. Upon reaching maturity, I estimated them to fall into the following groups: 28%, raspberry dominant; 41%, Louisiana berry dominant; 22%, intermediate; and 3%, indefinable.

The group in which the raspberry was dominant, might again be divided according to vigor into two groups, very strong and very weak, with intermediates tending to either extreme. The next thing that caught my eye was that, in the more robust group of the raspberry-dominants, there were five plants setting perfect fruits, and with showing for a good crop on each plant.

These five plants differed from each other in no other feature, except that one, which I named the First Choice, was of a greater size, and, on that account, bore a larger crop of fruit. They were all coarse raspberry forms, with heavy ascending or prostrate, terete canes covered with numerous weak, short prickles. The leaves were very large, of raspberry texture with three to five broadly ovate to rotund, coarsely serrate leaflets. The

A DEWBERRY-RASPBERRY HYBRID

The Louisiana dewberry (Rubus rubrisetus), when crossed with the Brilliant red raspberry (Rubus strigosus), gave hybrids in which the characters of the latter were dominant. In the F_1 generation the plants were quite sterile, only a few abortive fruits being produced; in the F_2, however, five plants bore good crops of fruit. Leaves and berries of the F_2 generation are shown above. (Fig. 12.)

flowers were intermediate in size between those of the original parents, and borne on elongated pedicels in clusters similar to those of the Louisiana berry. The fruit was dark cherry-red at maturity and brownish-black, when overripe. The size of it was much larger than that of either of the original parents; in fact, larger than any Logan blackberry produced on our grounds. The flavor was mildly acid with a strong reminder of the raspberry.

Two plantings of the third generation are growing on our grounds; one, made in the spring of 1918, from seed produced in the open, the other, planted in the field in 1919, from seed produced under screen. The first consists of about 900 plants which fruited in 1919. In general appearance, these vary no more from each other, or from their mother-plants in the second generation, than may be expected from descendants of what is recognized as a true species. The variations, such as they are, consist mostly in vigor of the shoots, size of the leaves, size and abundance of the fruit, and the time and length of the fruiting period. The general type and characters of their various organs are the same.

According to these variations, I marked, from time to time, as the fruiting proceeded, twenty-four as elites; but as the season advanced, I dropped this number to 4,—among which, I am as yet undecided as to the preference.

As to flavor, form, and color of fruit, no positive distinction can be made. The fruit differs from both the blackberry and the raspberry in the mode of separating from the pedicel, inasmuch as this takes place at the base of the calyx, leaving the latter attached to the fruit. Because of this, the picking of the berries is a little difficult, since there is not a well defined node, where the disjointing takes place. No positive variation in this character has given opportunity for selection.

REMARKABLE LENGTH OF FRUITING SEASON

The four plants of the third generation, finally selected as elites, produced fruit from the middle of May to the middle of August; hence the length of the fruiting season during the past summer was about three months. Another noticeable character was, that the fruit did not perceptibly deteriorate in size or flavor as the season advanced. The later part of the crop was produced on shoots of the current season. This character, which results in a long season of bearing, is evidently inherited, in a great measure, from *Rubus rubrisetus*, where this tendency is present, but less evident.

The most remarkable part of these phenomena appears to me to be that fertility appeared only in the most robust group of those of the F_2 generation, in which the raspberry was dominant, and did not reappear, just as though sterility was merely a passing crisis.

Self-pollination, both in te fiveh plants of the second generation, and in their descendants of the third, was perfect under screen; and their pollen, when used in crossing even distantly related forms, gave rise to apparently good seed. I have also crossed both the second and the third generation with foreign pollen with excellent results. With the second generation plants as mothers, and McDonald Spineless-diffuse as father, I have three thrifty hybrid plants. With another form as mother, namely, Haymaker x Louisiana F_1, which in itself is very sterile, I have six very thrifty plants from seed secured in 1918. This combination is, therefore, (Brilliant x Louisiana) F_2 x (Haymaker x Louisiana) F_1.

Besides these, I have tried the pollen of the third generation in other crosses with surprisingly good results, so far as setting of fruit and production of seed are concerned. In short, the ease with which these plants lend themselves to hybridization with other forms astonished me, when I remem-

bered my previous difficulties and failures with some of their congeners.

As regards hardiness, both the second and the third generations have had ample tests on our ground and passed them without the slightest signs of discomfort. The drought and high temperature of the summer of 1918 was the severest in memory of even the oldest inhabitant, yet no individual in the entire third generation, of more than 900 plants, showed the slightest distress. The summer of 1919, has become noted for the opposite extreme, yet no deaths, or even diseases, have occurred among these plants.

FOR THE PROTECTION OF ANIMAL EXPERIMENTATION

THE JOURNAL OF HEREDITY wishes to call attention to the recent organization of the Committee for the Protection of Animal Experimentation. It is the intention to form a permanent organization of laymen and scientists. The purpose is "to protect the public against all measures which tend to lower the standards of medical education and to combat the mischievous propaganda of all the various cults whose activities jeopardize the public health, including of course, especially the anti-vivisectionists and anti-vaccinationists."

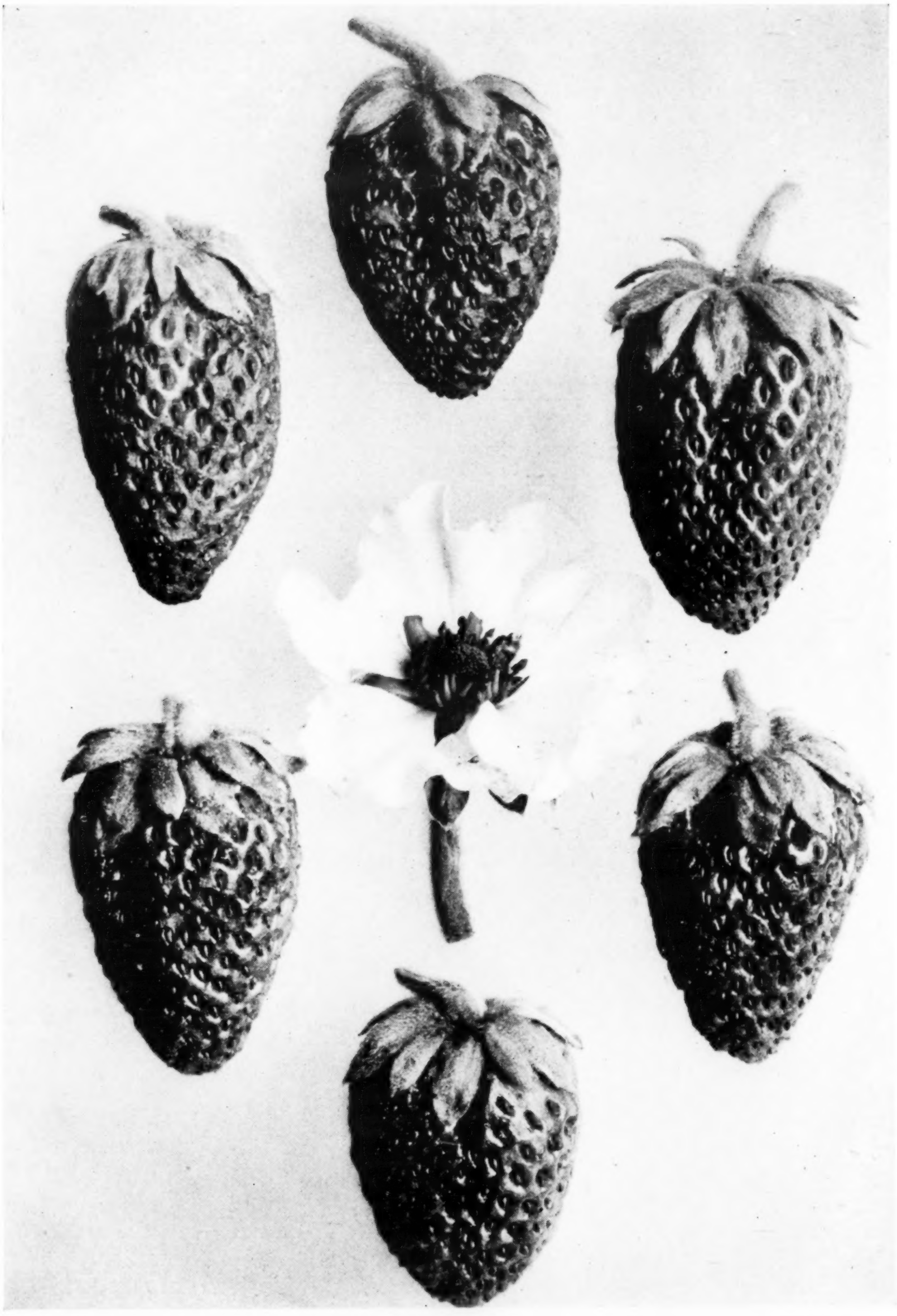
It is hardly necessary to say that the editorial board of the JOURNAL OF HEREDITY is in hearty sympathy with this movement.

It is an incontrovertible fact that the past progress in methods of curing diseases has been dependent, in the majority of cases, on experiments with lower animals; and in the nature of the case, the same must be true in the future. The alternative is progress by experimentation on human beings, sick or otherwise. Any form of treatment of sick persons is to some extent an experiment, but we naturally object to drastic experiments, made in ignorance, which mean almost certain death to the immediate subjects, even though there is a chance that in time knowledge may be obtained which will save many lives. Such experiments must be done with animals, with the elimination, of course, of all unnecessary suffering.

The modern theory of infectious diseases and the successful methods of prevention and cure to which it has lead in numerous cases, trace back directly to the experiments of Pasteur, Toch, Ehrlich and others with animals. Animal experimentation has also lead to better understanding and cure of deficiency diseases such as beriberi, and to the alleviation of functional disorders such as diabetes. Thousands owe their lives to surgical methods worked out at first with animals. Animals must be used in the standardization of useful but dangerous drugs, such as adrenalin and pituitary extract.

As geneticists, we believe that knowledge of the principles of heredity with respect not only to domestic animals and plants but especially to man himself is of the utmost of importance to mankind. It is very difficult to make progress in the direct study of human heredity. Eugenics must lean on experiments with the higher animals.

A number of statements have been issued by the above mentioned committee in which an illustration of the value of animal experimentation in the past is discussed at some length, and the importance to mankind of safeguarding it in the future is brought out by quotations from prominent men. The chairman of the Committee is Thomas Barbour, Natural History, Boston, Mass. Boston Society of 234 Berkeley St.,



THE CHILEAN STRAWBERRY, AS GROWN IN ECUADOR

The region of Ambato, Ecuador, has long been famous for its strawberries, which ripen throughout the year. The variety does not appear to be distinct from that grown in Peru and Chile, but the fruiting season is longer than in the latter countries, because of the equable climate which prevails in the Ecuadorean Andes. The berries are remarkably uniform in shape, and have unusual shipping qualities. They are here shown natural size. In the center is a flower: it will be noted that it has both stamens and pistols, though *Fragaria chiloensis*, when cultivated in France, is said not to produce stamens. (Fig. 13.)

THE FRUTILLA, OR CHILEAN STRAWBERRY

WILSON POPENOE
Agricultural Explorer, U. S. Department of Agriculture

IN THE development of our cultivated strawberries, the frutilla (*Fragaria chiloensis* Duchesne) has played a major rôle. Large-fruited strawberries were not known in Europe previous to the introduction of this species in 1714. Up to that time, European horticulturists had contented themselves with the native wood strawberry (*F. vesca*), the Hautbois (*F. moschata* or *F. elatior*), and the Virginian strawberry (*F. virginiana*), which latter was not introduced from America until after 1600. All of these are small-fruited, though of good flavor and quality. By crossing with *F. chiloensis*, horticultural forms were developed which combined large size with delicate flavor, especially in those cases where *F. virginiana* entered into the combination. The varieties thus obtained were the progenitors of the cultivated sorts now grown not only in Europe, but also in North America and elsewhere.

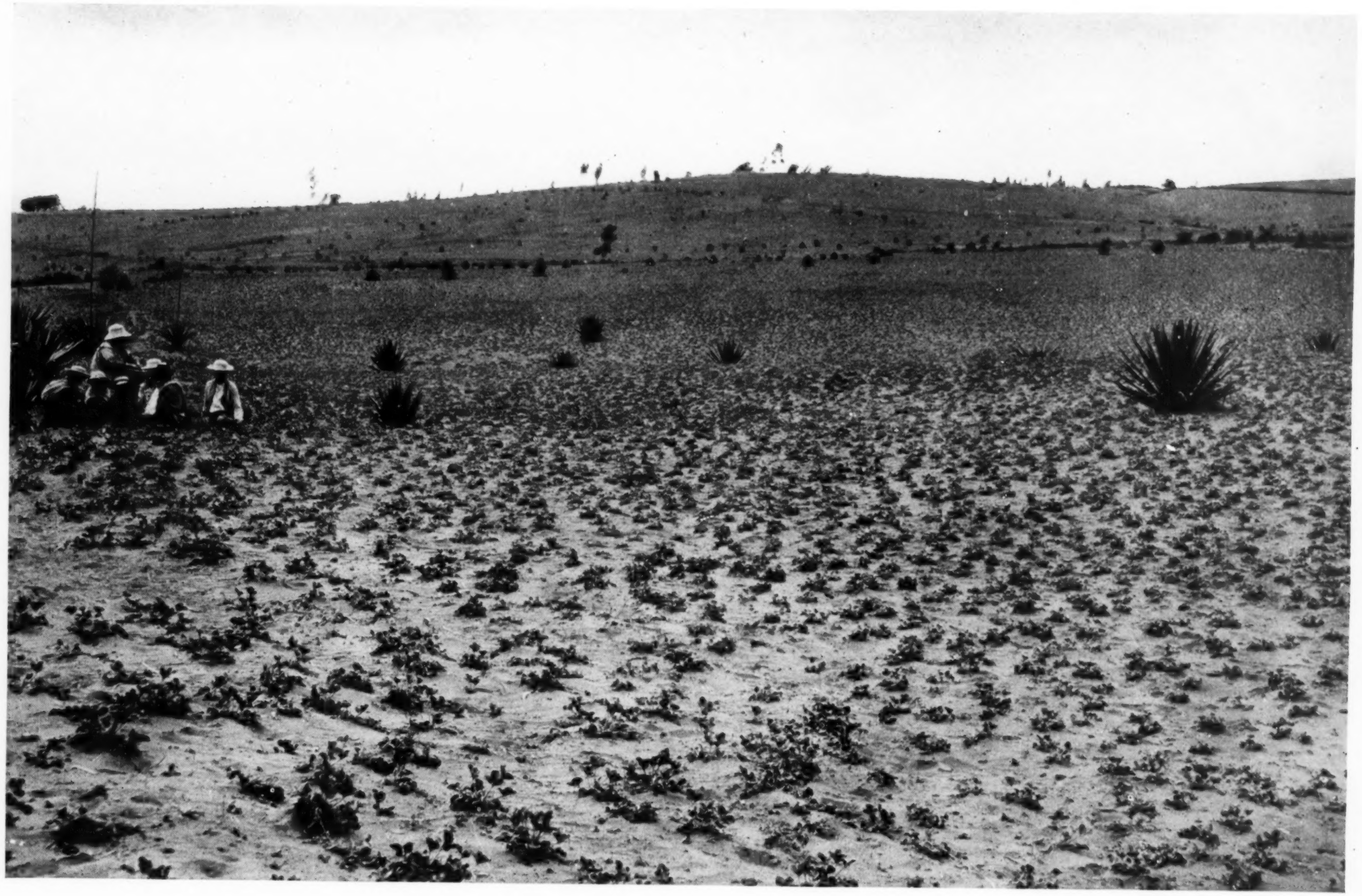
Fragaria chiloensis is considered to be indigenous along the Pacific coast from Alaska to southern Chile, though the differences which separate some of the South American forms from those of North America are great, and further study may show that more than one species is involved. Regarding its occurrence in Alaska, Georgeson[1] writes, "It grows along the coast from Muir Glacier to Prince William Sound, and probably also in other places, but throughout this region it is quite abundant. Its favorite soil is the sand and gravel along the old beach line just above the reach of high water. It here disputes the possession of the surface with grasses and weeds of many kinds and is quite able to hold its own against them."

Farther south, on the coast of California, the species occurs abundantly in certain parts. Albert F. Etter[2] says, "In this region they are found only along the coastal bluffs and on sand dunes on the ocean shore. Of all fruit-bearing plants they are among the hardiest, being able to fight for existence among rough grasses and weeds, battling against harsh exposure and gales, and even salt spray from the breakers. . . . The foliage is dark green and heavy, tough and leathery in texture. The blossoms are large to very large, the male and female blossoms being borne on separate plants. This peculiar character, however, does not hold in the forms of the species found in other parts, those from South America being bisexual. The foliage of the southern form is also very distinct, being light green and fuzzy. Even such close points as Cape Mendocino and Point Arena have very different forms, while those from Alaska would hardly be recognized. The fruit varies as much as the plants in different regions. That from Chile and Peru is very large and often irregular in form, borne on long trusses, and of light pink or white color. . . . At Point Arena the fruit is borne on long trusses, is almost red, and is soft and fragile. At Cape Mendocino the fruit is pink, and borne on a very short truss."

EARLY HISTORY IN SOUTH AMERICA

Nowhere in North America is *Fragaria chiloensis* a cultivated plant. On the western coast of South America, however, it forms, in certain regions, an important culture, and has done so for several centuries. Frezier, who introduced the species into Europe, wrote in 1717 of its occurrence in Chile,[3]

[1] Georgeson, C. C. Annual Report, Alaska Exp. Sta., 1909.
[2] Ettersburg Strawberries, published by the author at Ettersburg, California, 1920.
[3] Frezier, M. Relation du Voyage de la Mer du Sud. Amsterdam, 1717.



THE STRAWBERRY FIELDS OF GUACHI, ECUADOR

Probably the most extensive strawberry plantations in South America are those located at Guachi, near Ambato, Ecuador. This region lies at an elevation of about 9500 feet; the climate is dry, cool, and equable, and the soil is a very sandy volcanic loam. Little cultural attention is given the plantations, and they are never irrigated; nevertheless, they produce, throughout the year, fruits of large size and delicious flavor. It will be noted that the plants have a dry, stunted appearance; this is one of the characteristics of *Fragaria chiloensis* as grown in Ecuador. When planted on rich soil, and irrigated abundantly, it makes luxuriant growth, but produces few fruits. (Fig. 14.)

"They cultivate fields of a species of strawberry different from ours in having more rounded, thicker and more hairy leaves; the fruits are commonly as large as a walnut, and sometimes the size of a hen's egg; they are whitish red and a trifle less delicate in flavor than our wood strawberries."

The historian Garcilaso de la Vega[4] records the introduction of the species into the highlands of Peru shortly after the Conquest. "Another fruit which they call Chili," he writes, "was brought to Cuzco in the year 1557. It is of very good flavor, and much used for presents. It is borne upon a low plant, almost trailing on the ground; it has little grains outside like the fruit of the madroño (arbutus) and is the same size, not round, but rather long, in the shape of a heart."

The Spaniards also carried the plant into Ecuador, though I have been unable to find any record of the exact year in which it reached that country. Father Velasco,[5] writing in 1789, calls it *frutilla*, or freza quitense (Quito strawberry), and says that the fruit is two or three times the size of the European strawberry. He adds "It is produced through the entire year, and although it is common in several provinces, in no other is it so abundant, nor so excellent, as in that of Ambato." Later writers, also, have praised the strawberries of this favored portion of Ecuador. Richard Spruce,[6] though mistaken as to the botanical identity and origin of the species, comments in the following interesting manner upon it: "The Everbearing Andean Strawberry, from the highlands of Mexico, is doubtless one of those varieties of *Fragaria vesca*[7] commonly cultivated throughout the Andes within the tropics, where the perpetual spring of that favoured region has had the effect of rendering the strawberry perennially fruitful, and many of the deciduous-leaved trees of Europe evergreen. In the equatorial Andes the province of Ambato is famed for its strawberries, which equal in size and flavour some of our best varieties, and are to be seen exposed for sale in the market-place of Ambato every day in the year."

THE STORY OF ITS INTRODUCTION INTO EUROPE

The introduction of *Fragaria chiloensis* into Europe, because of the important part it was destined to have in the development of cultivated strawberries, is worthy of more than passing notice. M. Frezier, a French officer, visited Chile in the year 1712, and spent some time in the region of Concepción, where he had opportunity to become familiar with this fruit. The classic Duchesne[8] gives the following account of his return to France and the successful introduction of the plant into that country:

"It is to the zeal and perseverance of this alert traveler that Europe owes this fine race of strawberries; I quote from his letter to me: 'I have returned,' says M. Frezier, 'in a merchant

[4] In the "Comentarios Reales," of which the first part was published at Lisbon, in 1609, and the second part at Cordoba in 1617. This is one of the classic works on the history of Peru.

[5] Velasco, Juan de. Historia del Reino de Quito en la America Meridional. Written in 1789, and published at Quito (Imprenta del Gobierno) 1844.

[6] Notes of a Botanist on the Amazon and Andes, London, 1908.

[7] While Spruce, who traveled in Ecuador during the years 1857–1860 (though his notes were not published until 1908), erred in considering this to be the species cultivated near Ambato, it is worthy of note that the true *F. vesca*, a native of Europe, has become naturalized in many parts of the Andean region, where it was doubtless introduced by the Spaniards at an early date. In the vicinity of Bogotá, Colombia, it grows abundantly at elevations between 6000 and 9000 feet, chiefly along roadsides and about cultivated fields, and the fruit is sold in the markets of the city nearly every day in the year. In Ecuador it occurs both wild and cultivated, but the fruit is not much used, the plant being esteemed more as an ornamental than for its berries. These are rarely more than half an inch long, and while somewhat dry, and at times possessing a slightly bitter taste, they are very good when stewed or made into a rich preserve, which latter is one of the favorite desserts of Bogotá. In parts of northern Ecuador *F. vesca* is called *frutilla*, but in the southern part of the country, where the true *frutilla* is grown, the correct Spanish name *fresa* is current.

[8] Duchesne fils, M. Histoire Naturelle des Fraisiers. Paris, 1766. The first published monograph of the cultivated strawberries, and a work of great importance.

vessel of Marseilles, owned by the brothers Bruny, and on which they had placed as supercargo their nephew M. Roux de Valbonne, who, after the Captain, had charge of the fresh water which was carried on board, and which is very precious on a voyage of six months duration, through the Torrid Zone; so that, if he had not been generous enough to have the plants, which were in a pot of soil, watered, it would not have been possible to keep them alive until we reached Marseilles.[9] Five of them arrived in good order, of which he took two, while I reserved three for myself. On my arrival at Paris, I gave one of these to my friend M. Antoine Jussieu, to be planted in the Royal Garden; one to M. le Pelletier de Souzy, our minister of fortifications, and the third I retained.'" Frezier later published, in his "Relation du Voyage de la Mer du Sud" a drawing of the plant and its fruit, with the title, "Fragaria chiliensis, fructu maximo, foliis carnosis, hirsutis, vulgo frutilla" and below, "Fraise du Chili dessinée de grandeur naturelle."

Duchesne remarks that, after the introduction of these five plants, "the *frutiller* was soon disseminated throughout Europe." In his discussion of the establishment of the species in France, he accounts for only three of the five specimens brought by Frezier. The two which were taken by M. Roux de Valbonne do not again figure in the story. Very soon after its introduction, the species was cultivated commercially in the vicinity of Brest, but in 1766 its importance had greatly declined, according to Duchesne, because the plants were unproductive. Evidently many of them were pistillates, instead of hermaphrodites; in fact, Duchesne thinks that all of them may have been so, and that fruit was only produced when they were supplied with pollen from one of the other species then cultivated in France. So far as I have observed, the plants cultivated in Chile, Peru and Ecuador always produce perfect flowers; can it be that the unaccustomed climatic conditions to which they were subjected in France caused them to abort the stamens?

At this point it is of interest to consider the derivation of the name given to the species. Frezier, who published his book in 1717, calls it "Fragaria chiliensis," while Duchesne, who monographed the strawberries in 1766, changes it to "Fragaria chiloensis." The island of Chiloe, which lies off the coast of Chile between latitudes 42 and 44 S., approximately, is one of the regions in which this large-fruited form occurs as an indigenous species, and the logical assumption would be that the specific name *chiloensis* was formed from that of the island; yet Duchesne says nothing to this effect, and the fact that Frezier, in his earlier work, uses the form *chiliensis* shows that he, at least, desired to name the species after the country, Chile, instead of for the island, Chiloe.

Several authors give *quelghen* as the indigenous name of the fruit. *Frutilla* is the term universally employed for the species by Spanish-speaking people on the western coast of South America; the Spanish name of the European strawberry, *fresa*, is reserved for the fruit of *F. vesca*. A strawberry field, if the plants are of the *chiloensis* species, is termed a *frutillar*, and there is a town by this name in southern Chile. In the United States the names Chilean strawberry, sand strawberry, beach strawberry, and probably several others have been applied to the species.

PRESENT STATUS OF FRAGARIA CHILOENSIS IN SOUTH AMERICA

The horticultural importance of this strawberry in South America is considerable. I have not been in Argentina to determine whether or not it is cultivated there, but on the western side of the continent it is grown in nearly every country. Beginning in the north, it is cultivated in the vicinity of Bogotá, Colombia, though not extensively so. In the months of Decem-

[9] The 17th of August, 1714, according to J. H. Blanchard, who gives a detailed account of the Frezier voyage in the Journal of the Societe Centrale d'Horticulture de France, XII, p. 628, Paris, 1878.

A GROUP OF ECUADOREAN STRAWBERRY PICKERS

Fragaria chiloensis is the most remarkable of all strawberries, in so far as shipping qualities are concerned. It is the custom, in Ecuador, to throw the fruits into boxes such as the one here shown: they are then carried six or seven miles on mule-back to the city of Ambato, where they are sorted by hand, and packed in baskets holding two to six quarts, for shipment by train to Quito or Guayaquil. There is probably no other strawberry in the world which would tolerate this sort of handling. (Fig. 15.)

THE CHILEAN STRAWBERRY IN THE HIGHLANDS OF PERU

In the valley of the Rio Urubamba, not far from Cuzco, the ancient capital of the Incas, the Chilean strawberry is grown on an extensive scale. Many of the plantations, including the one here shown, have been made upon *andenes* or agricultural terraces which were constructed in prehistoric times. In this region, which lies at an elevation of about 9000 feet, *Fragaria chiloensis* does not fruit throughout the year, as it does in Ecuador. This photograph was taken near the village of Yucay, looking down the valley toward the town of Urubamba. (Fig. 16.)

ber and January the fruits are occasionally offered in the markets of that city, prepared for sale in a unique fashion: they are gathered with long stems, and then tied together one above the other to form strings a foot or two in length. The common name *fruta de Chile* is applied to the species in this region.

I have not seen the species in the western part of Colombia, but farther south, in the highlands of Ecuador, it is extensively cultivated, mainly in the region of Guachi, a settlement not more than six or seven miles from Ambato. Here the plants bear fruit throughout the year,—a characteristic which they do not exhibit in Peru and Chile, probably because of the utter lack, in Ecuador, of well-defined seasons.

Guachi lies at an elevation of 9500 to 10,000 feet, and is a series of rolling hills, almost devoid of trees, with a soil which can be characterised as a very loose, fine, sandy loam of volcanic origin. The strawberry plantations cover an area of at least 60 acres; the plants are never irrigated, and the rainfall is probably not more than 15 inches per annum. The temperature is rarely higher than 65° or 70°; and seldom lower than 35° F. above zero. Severe frosts are unknown. Three times a year the fields are cleaned of weeds with a heavy hoe, this being the only cultural attention which they receive. The plants never grow to large size. The natives assert that when irrigated they make luxuriant growth, but do not yield abundantly nor is the fruit large and sweet; and this has, indeed, been observed by me to be the case when plants from Guachi are taken to Ambato and there grown on rich loamy soil under good cultural conditions.

The fruit is harvested at Guachi once a week throughout the year. There are, however, three seasons when the most abundant yield is obtained, these being in February, in August, and in December. The method of handling the berries is primitive; they are carried to Ambato in wooden boxes holding 30 to 35 quarts. Women in the market place grade them by hand, and pack them in baskets of varying sizes, for sale to passengers on the Guayaquil—Quito trains which pass through the town, or for shipment to these and a few other points.

In size, shape and other characteristics the strawberries of this region are remarkably uniform. They are oblong-conical in outline, sometimes oblong-ovoid, and from one to two inches in length. When fully ripe they are light red in color, with firm, meaty, pinkish white flesh. The flavor is perhaps not quite so aromatic and sprightly as that of some of our best North American and European strawberries, but it is very delicate and pleasant. For canning and shipping purposes the Guachi strawberry far excels any of our own. What sorts have we, may I ask, which could be thrown into boxes holding 30 to 35 quarts, carried seven or eight miles on mule back, worked over by hand and packed in two to six-quart baskets, and then shipped down to a tropical seaport, there to be kept in the market for two or three days at a temperature of 70 to 85 degrees? Even with such treatment as this, the Guachi strawberry holds up well, retaining its shape and texture to an extent altogether unknown among northern strawberries. This same characteristic shows up strongly when the fruit is canned or preserved; the berries retain their form and size nearly as well as do peaches,—far surpassing in this respect any of our North American strawberries—and have a very delicate flavor. In comparing a tin of the preserved fruits brought from Chile, however, with a good North American pack, and with preserved strawberries of the Portia variety, George M. Darrow and myself both thought chiloensis, as represented by this sample, not so richly flavored as the best of our own sorts. It has delicacy, and, in the fresh state, a delightful, though rather faint, aroma; but it has not sufficient acidity to make a really excellent canned fruit.

CULTIVATED IN THE HIGHLANDS OF PERU

In Peru, there are numerous plantations of chiloensis in the valley of the

A STRAWBERRY FIELD IN CENTRAL CHILE

Near the town of Quillota, not far from Valparaiso, *Fragaria chiloensis* is extensively cultivated to supply the canning factories which have been established in this region. Here is shown a young peach orchard in which strawberries have been planted as a secondary crop. Chilean growers irrigate their strawberry fields, and as a consequence, the plants make more luxuriant growth than they do on the dry plains of the Ecuadorean highlands; but the fruit produced is perhaps not so highly flavored as that of Guachi, Ecuador, nor do the plants bear throughout the year as they do in the latter region. The ripening season in central Chile extends from the first of December to the end of January. (Fig. 17.)

Rio Urubamba, not far from the city of Cuzco, at elevations of 9000 to 9500 feet. Several of the best are near the village of Yucay, on large *andenes* (artificial terraces) built in the days of the Incas. Here the plants are more vigorous in growth than at Guachi, but the fruiting season is not nearly so long; I am told by T. E. Payne of Calca that the first fruits ripen about October 20, and the last ones about the end of January. The crop is marketed in Cuzco. I was not able to see ripe fruits grown in this region, but from descriptions given me I judge they differ very little from those of Ecuador.

In central Chile there are numerous plantations, from which the fruit is either shipped to the markets of Santiago or used for canning and preserving. In one field which I examined, not far from Santiago, the plants were exceedingly robust and vigorous in appearance, both leaves and flowers standing upon stems six to ten inches long. The appearance of such plants is quite different from those of Guachi, Ecuador, where the leaves rarely stand more than three or four inches above the ground, and where the plants have a dried-up, starved appearance, but where, nevertheless, excellent fruit is produced throughout the year. In Chile, as in Peru, only one crop is obtained. The principal season in the vicinity of Santiago and Quillota is said to be December and January.

Two varieties are commonly recognized in Chile,—the common, light red one, and the *frutilla blanca*, whose fruit is ivory white to very pale pink. The red form is cultivated far more extensively than he white. From having examined the canned product, I judge that the size and character of the Chilean-grown fruits is not markedly different from that of the Guachi berries, but I am inclined to believe that the latter may be a little sweeter and more delicately flavored. There are several canning factories in central Chile, which turn out preserved strawberries as well as strawberry jam.

Because of the fact that no attention has been given to isolating good varieties of this berry, and because of the general confusion which surrounds horticultural matters in western South America, it is impossible to state just how many distinct forms of chiloensis exist in the several countries above considered. Certain it is that few well defined varieties are generally propagated or recognized by the inhabitants. In this connection it may be mentioned that a given variety of strawberry may sometimes change its shape and character when grown in different climates. Klondike, for example, is conic in Florida, globose farther north, and long conic and necked in California. Marshall bears but one crop in New England, but fruits throughout the summer in California. We can not assume, therefore, that the long fruiting season of the Guachi strawberry really constitutes a difference between that variety and the one grown in Chile; it is doubtless an effect of the almost total absence of well-defined seasonal changes, either of temperature or rainfall, which prevails on the Equator.

PROBABLY THE WORLD'S OLDEST CULTIVATED STRAWBERRY

Fragaria chiloensis of western South America is certainly one of the oldest cultivated strawberries in the world. I have seen no reference in literature to its horticultural status at the time of the Conquest: the indigenous inhabitants may have cultivated it since time immemorial, and even if they did not, it can safely be assumed that it has been grown in gardens since the colonization of Chile by the Spaniards. In all this time only two well-defined varieties seem to have appeared, the red-fruited and the white-fruited. The first-named has been cultivated continuously in the highlands of Peru since 1557,—nearly four centuries. This offers a rather striking refutation of the argument that strawberry varieties "run out." Those which have been produced by hybridization may change their character or "run out" in a relatively short time,—I do

not know the facts of the case,—but certainly it cannot be said that the red-fruited form of *F. chiloensis* which is cultivated in Peru and Ecuador shows any signs of so doing!

Duchesne writes of this species that it is more robust, and larger in all its parts, than any of the other strawberries, and that it makes the slowest growth of all, some plants not flowering until they are five years old. It does not produce runners as freely as the horticultural varieties now grown in North America. The flowers, particularly those which appear at the beginning of the season, stand high above the ground on thick, hairy stems, and are fully an inch in diameter. When a field of this species is in full bloom it is almost as fragrant as an orange grove.

Fletcher,[10] in describing the principal characteristics of *F. chiloensis*, says: "The plant is large, stocky, densely hairy, with large blossoms. It throws out a moderate number of short, stout runners mostly after the fruit has matured. The roots are rather thick, fleshy, and usually are more superficial than those of *F. virginiana*. When a plant grows in the same place for several years the crown does not divide low down, as in *F. virginiana*, but makes several large crowns high up, all attached to the main root stalk. The plant is pushed upward out of the soil and new roots form above the old ones."

We have it on Duchesne's authority that the stamens are abortive, and that no pollen is produced. This certainly is not true of the species as it grows in South America. The fruits, because of their large size and unusual texture, have been, and will continue to be, of great interest to strawberry breeders in North America, Europe, and other regions. It is doubtful if the varieties which are cultivated in South America will be of great value to us, for commercial purposes, until they are crossed with forms better adapted to our climatic conditions. There is no region in the United States with a climate approximating that of Guachi, Ecuador; the distance which separates us from the Equator precludes all possibility of such a thing. We can not, therefore, expect the Guachi variety to fruit throughout the year in any part of this country.

Certain sections of California are very similar to central Chile, in so far as climate and soil are concerned. The region of Santiago has about the same summer climate as Los Angeles, and a winter which is sometimes, but not often, a few degrees colder. The Chilean varieties may; therefore, succeed in southern California, but if they produce fruit only during two or three months of the year, as they do in Chile, they will not be commercially valuable to us. They will, however, be useful to breeders, and from this point of view the value and importance of the horticultural forms from South America cannot be over- mphasized. They will give size, texture, and perhaps, ability to resist drought, to many of our important strawberries of the future. One breeder goes even further: Albert F. Etter of California, whose work in strawberry improvement is noteworthy and entitles him to speak with more than ordinary authority in such matters, ventures the prediction that the "most exquisite flavors the strawberry will ever know will be derived from the various forms of the chiloensis species."

[10] Fletcher, S. W., The Strawberry in North America, New York, 1917.

NATURAL HYBRIDIZATION OF WHEAT AND RYE IN RUSSIA

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IN 1918 at the Experimental Station in Saratov, in southeastern European Russia, a truly extraordinary phenomenon was witnessed of the mass appearance of natural hybrids (F_1) between wheat and rye, in a number of plots of winter varieties of wheat (*Triticum vulgare* v. *erythrospermum*, v. *Hostianum* and v. *pyrothrix*). The number of these hybrids was not the same in all plots. They were altogether absent in some; in others they were occasional; in still others their number was considerable; while in the plot No. 648, v. *erythrospermum*, 20% of the plants were hybrids. Altogether many thousands of natural wheat-rye hybrids were observed.

The plots in which a large number of hybrids occurred are characterized by early ripening, and if they do not flower simultaneously with the rye, the period of their blooming, at any rate, partially coincides with the blooming of the rye. These varieties of wheat have a considerable opening of the flower glumes in blooming, which facilitates natural hybridization.

The climate of Saratov is continental and dry, with a precipitation of only about 380 mm. The natural hybridization of wheat here is such a usual event that in 1919, for example, we collected over three hundred plants of hybrids (F_1) between *Triticum durum* v. *hordeiforme* and *Triticum vulgare*.

It should be added here that 1917, the year preceding the appearance of the wheat-rye hybrids, was a particularly dry year; and also that in order to avoid their cross-pollination, the varieties of wheat were separated by protecting rows of rye—in short, all conditions favorable for the formation of hybrids were present.

The mass appearance of hybrids in the plot No. 648 should be attributed to the peculiar biological character of this variety of wheat. This variety is characterized in general by weak frost resistance. The hybrids (F_1), on the other hand, so far as frost resistance is concerned, are more like the rye. They survive even in places where winter wheat perishes entirely. This fact was further attested by the behavior of the hybrids in their later generations.

We were successful in collecting a considerable number of hybrids in 1919 and 1920, and in this way we have assured the work with them also for the future.

From the botanical point of view, the wheat-rye hybrids of the first generation occupy an intermediate position between *Secale* and *Triticum*, in the majority of their features, with a certain predominence of wheat properties. The general habit of the plant is that of wheat rather than of rye, but in the majority of the culms the upper part of the peduncle just below the base of the ear is hairy like rye.

In literature on wheat-rye hybrids, beginning with *Rimpau* descriptions are given of the first generation (F_1) of these plants so we shall not describe them in this short note.

Let us turn to the fertility of the hybrids of the first generation: As was

[1] Translated from original manuscript in Russian by Prof. N. I. Vavilov.

NOTE: In reference to the natural hybridization of wheat and rye, which is the subject of Mr. Meister's article, it will be of interest to recall that Dr. C. E. Leighty reported in the Journal of Heredity for March 1920 that the season of 1917 at Arlington Farm (near Washington, D. C.) seemed to be uncommonly favorable for cross pollination of cereal varieties, 19 natural wheat-rye hybrids (F_1) being found in 1918, while cross pollinations between different varieties of wheat occurred in unusual numbers; and likewise crosses between varieties of barley.—EDITOR.

shown by the investigations of Tschermak, Jesenko and others, these hybrids are generally sterile, which is explained by the irregular division of cells in the pollen. The stamens are insufficiently filled with pollen, are covered with thick films and in the absence of the necessary turgor generally do not dehisce. The pollen is amorphous, for the most part, but frequently there can be found some pollen with well defined nuclei and firmer granulation. Like Jesenko, we did not succeed in obtaining self-pollination in hybrids. There were 220 isolated heads which did not yield a single seed.

Still, during a period of three years about 1200 seeds were obtained from these hybrids. The number of heads with seed varied in different years from five to ten per cent of the total number of heads, there being generally not more than one seed to a head, rarely two or three. The seeds are of the wheat type, but occasionally somewhat elongated, approaching the shape of rye.

Here arises the question: If self-pollination in hybrids (F_1) is impossible, how were the seeds obtained by Rimpau, Carmen—and at our station? Dr. Jesenko explains the derivation of the seeds as being due to the crossing of the hybrids with rye and wheat, the possibility of which he proved by experiment. In a test made at our station in 1919 with 970 flowers pollinated by wheat, we succeeded in obtaining five seeds; 1012 flowers pollinated by rye gave one seed. In 1920, on pollinating 870 flowers with rye, not a single seed was obtained; while 220 isolated heads also failed entirely to yield seed. So far everything goes to prove that seeds are obtained in first-generation (F_1) wheat-rye hybrids only when their flowers are pollinated, preferably by wheat, or sometimes by rye pollen. But on account of certain considerations, we believe this matter has not been sufficiently cleared up.

I shall now consider the hybrids of the second generation. Germination of the seeds is about 70 to 80 per cent; the shoots are coloured or not coloured with anthocyanin; albino plants were noticed in the progeny of only one plant. The winter form of the hybrid plants varies considerably—from a rosette with stalks pressed to the ground, to an upright bush with non-spreading stalks; not infrequently the plants have narrow needle-pointed leaves, like those found on certain wild grassses. But these forms usually perish in the autumn.

The plants vary greatly in the length and width of the leaf blade, exceeding by far the parental types of leaves in these respects. The measurements of the stomata is interesting. The numbers of stomata observed through the microscope, and their measurements in microns, are as follows: in wheat 77 with an average length of 52.8 microns; in rye 78, average length 46.5 microns, in F_1 hybrids 96, average length 47 microns. The maximum number of stomata of the F_1 hybrids was 110 (maximum number in wheat 104) with a maximum length of 73.6 microns, (the maximum noted in wheat is 63.0).

The first year (F_1) seeds were sown in the field and only about 20 per cent of the plants were placed in the greenhouse for the winter, but even under these conditions only 60 or 80 per cent survived. Subjected to a detailed botanical analysis 209 plants gave the following results: two typical rye plants with apparent inclination to self-pollination, seeds being formed even under the parchment packet enclosing the head; 87 plants clearly of the *Triticum* type, but in these frequently were noted several minor morphological features of rye, such as the shoots colored with anthocyanin, lengthening of the flowering glumes, tender awns, carina on the flowering glumes, etc., whereas the forms corresponding to the parent forms were missing. Twelve plants were entirely new forms with long heads, with a large number of spikelets and narrow elongated flowering glumes. In these plants the rye features were predominant, but the empty glumes were many-nerved, and the seed typical of wheat. Finally, 102 plants were placed by us in the

intermediate type, with a larger or smaller number of rye features. All the hybrids, with the exception of two which were typically rye, had wheat seeds and many-nerved empty glumes.

In many hybrids the blooming is not normal. Blooming with widely open flowering glumes predominates; sometimes the anthers do not crack and have a small amount of pollen. A good deal of the pollen is amorphous. In several plants a certain discord in the organs was noticed for example green anthers were thrown out on long threads and then faded, etc.

As regards the fertility of hybrids: typical rye and typical wheat plants in most cases have a normal fertility, but several plants with ears of the square-head type are all sterile. The fertility of the other plants definitely falls as the rye features increase.

The following are the figures for fertility: 29 per cent entirely sterile plants; 42 per cent with one grain each; 11 per cent with normal fertility; the remaining 18 per cent occupy an intermediate position. All the more or less new or original morphological forms are either sterile or bear single seeds.

The new features established are: the narrow, needle-pointed shape of the leaves; thick leaves; great brittleness of the rachis of the ear; very rough awns; thick stems and other features as enumerated above, which indicate a strong deviation from paternal forms.

In the third and fourth generation we have, obviously enough, almost exclusively either typical rye or typical wheat plants, to which we shall confine ourselves, as there were too few hybrids of the intermediate type in these generations. First of all we must point out that F_1 hybrids whether typical rye or typical wheat continue their form into future generations. This constancy, it seems, is characteristic also of the plants of intermediate type. Within these fixed basic forms was noticed only the segregation of individual features. Thus, for example, in one wheat family a simple Mendelian segregation of 1 : 3 occurred with respect to presence and absence of awns; in three families, with respect to hairiness of the upper part of the culm the total numbers gave the approximate ratio 1:15. In other features nothing approximating any fixed segregation could be established.

In the third generation we have 20 per cent entirely sterile plants or with one seed only, and 53 per cent normal plants, sometimes with very good seed.

Now comes the question: If in segregation we notice the separation of two basic forms of the *Triticum* and *Secale* plants, what about those properties which regulate their frost resistance? We are not yet in a position to give a definite answer to this question. Considering the presence in plants of several symptoms of opposing morphological features, we have no reason for denying the possibility of similar phenomena in the physiological properties of the plants. But, so far we must confine ourselves to quoting several appropriate facts.

In the winter of 1920 the hybrid plants were kept in a special hothouse at a temperature of 1°—2° C. This temperature proved particularly favorable for the growth of the fungus *Fusarium nivale*. The hybrids were planted in boxes containing 45 plants each. In one rye family 96 per cent of the plants perished from fungus, and as one box was planted only partly with rye and the rest with another wheat family, we were able to note in the latter the complete absence of attacked plants. The absence of the mycelium of this fungus was noted in four families of the wheat type, in fifty-five families the destructive fungus was present in from seventeen to sixty-two per cent of the plants, and in 113 families there was a slight blight on the plants with but small loss; characteristic segregation was noted in susceptibility to *Fusarium nivale*.

Leaving aside for the time being the question of the difference in susceptibility to the fungus *Fusarium nivale* of the parent forms—a question that has not been cleared up by us—we can, so far, on the basis of the

above facts, make only the statement that among the wheat-rye hybrids segregation was noticed with respect to the effect of the fungus. This fact is in itself sufficiently valuable in the general problem of creating forms of plants resistant to winter injury.

I shall now describe another group of experiments: In the autumn of 1920 we were first able to sow in a field 287 families of hybrids of the third and fourth generations 1 to 10 rows of each, and 25 plants to a row.

The autumn of 1920 was very dry and the sowing had to be done late. Winter then came on early with the result that only the rye type tillered normally; plants of the wheat type tillered hardly at all. The winter was almost without snow. The small quantity of snow that did fall on the fields thawed under the first rays of the spring sun. The parent forms sowed in frequent repetition gave the following results: the wheat perished entirely; on the rye plots up to 23 per cent of the plants perished. Now what happened to the hybrids?

Secale hybrids: in one family consisting of 166 plants only six plants survived, these being evenly distributed over the whole area of the plot. The others perished during the winter. This was not noticed on a single rye plot. The destruction of the plants of this family cannot be explained by the micro-relief of the surface. The plants of this family were characterised by a low spreading growth resembling wheat rather than rye in form of growth. Of the remaining hybrids of the rye type, four stood the winter well like rye. In one family increased frost resistance was noticed, while the remaining 29 families of rye type there was from 36 to 76 per cent destruction.

Naturally then, we arrive at the conclusion that the winter resistance of certain hybrids of the rye type has decreased as the cost of obtaining certain wheat properties.

Triticum hybrids: of the 289 families of the unsatisfactorily developed hybrids, as we said above, but four survived the winter. Subsequently the great majority of the surviving plants perished, as during the days there was great heat, and in the night frosty weather, followed by very dry weather with a drop in the humidity of the air to 20 per cent or lower. Nevertheless, in spite of the extraordinarily unfavorable conditions, we still have at the present time over 300 plants well developed and that have stood all these reverses. At any rate, in this we are able to observe increased winter resistance.

I do not draw any conclusions from the above mentioned facts. Subsequent investigation will undoubtedly make it possible to reach a conclusion on the question that interests us, but I find it necessary to remark that material very limited in its variation was sown in the fields, having a beginning only from 30 F_2 plants, in their turn descended from 30 F_1 plants of such complex constitution as hybrids of wheat and rye, in which are mixed an endless number of different features. It is understood that such a number of plants cannot be in any way considered as sufficient to solve the question on hand.

Life of the Honey Bee

A Book About the Bee, by Herbert Mace. Pp. 138, with 24 illustrations. New York, E. P. Dutton, n.d.

This unpretentious little book, printed in Great Britain, gives a simple and non-technical account of the life of the hive. While the author outlines some of the notable problems pertaining to heredity and evolution among bees, he makes little attempt to suggest solutions for them. As a primer, however, the book should be useful. The photographic illustrations are excellent.—P. P.

THE VIRGINIA OPOSSUM

PHOTOGRAPHS OF TWO NEW VARIETIES AND THE TWO NORMAL PHASES OF THIS ANIMAL[1]

CARL HARTMAN
University of Texas, Austin

THE published descriptions of *Didelphys virginiana* concern themselves almost exclusively with the gray phase shown in Fig. 18 (E and F) in the photographs on the following page. This is the common Virginia opossum. The animal appears gray because the long overhair is white, the soft dense underfur being tipped with black.

Now and then, however, one meets in the literature a casual reference to black individuals such as C and D, in Fig 18. This phase has not received the attention it deserves, for it occurs throughout the range of the Virginia opossum. The National Museum contains numerous black hides; and the writer receives from the Austin region one black to about ten grays. In the black phase the overhair is black, not white, although a few scattered white hairs may be present.

The two phases appear to the writer to be genetically distinct, that is discontinuous varieties, for no gradations between the two have been seen among a thousand animals examined.

In Fig. 18 are also shown two albinotic females received from Kenneth Nevins, Sulphur, Oklahoma. This variety seems to be new, at least the writer is unaware of any existing description of it, although he has heard numerous reports of the occurrence of white opossums in this section of the state. Three or four years ago the writer came into possession of just such an individual, also a female, a photograph of which is included among the illustrations furnished by the writer for the 1921 report of the Secretary of the Smithsonian Institution.

The albinos here shown have all white hair—there is not a single black hair on their bodies. The iris is somewhat lighter than the dark iris of the normal animal, but the eye as a whole appears black, not pink. The skin is black, however, in the usual pigmented areas: feet, ears, base of tail, and the streak between tail and cloacal orifice.

The second variety figured is true brown or "cinnamon." Three individuals are shown, one male (I, Fig. 19) and two females (G and H). These animals were presented by Dr. Chas. McNeil of Sedalia, Missouri, where the variety is said to be not uncommon. Here again the white overhair is either present all over the body, as in G and I, or absent, as in H. This last mentioned female possesses no white overhair; the fur is a uniform and delicate light brown. The specimen ought to produce a commercially valuable strain.

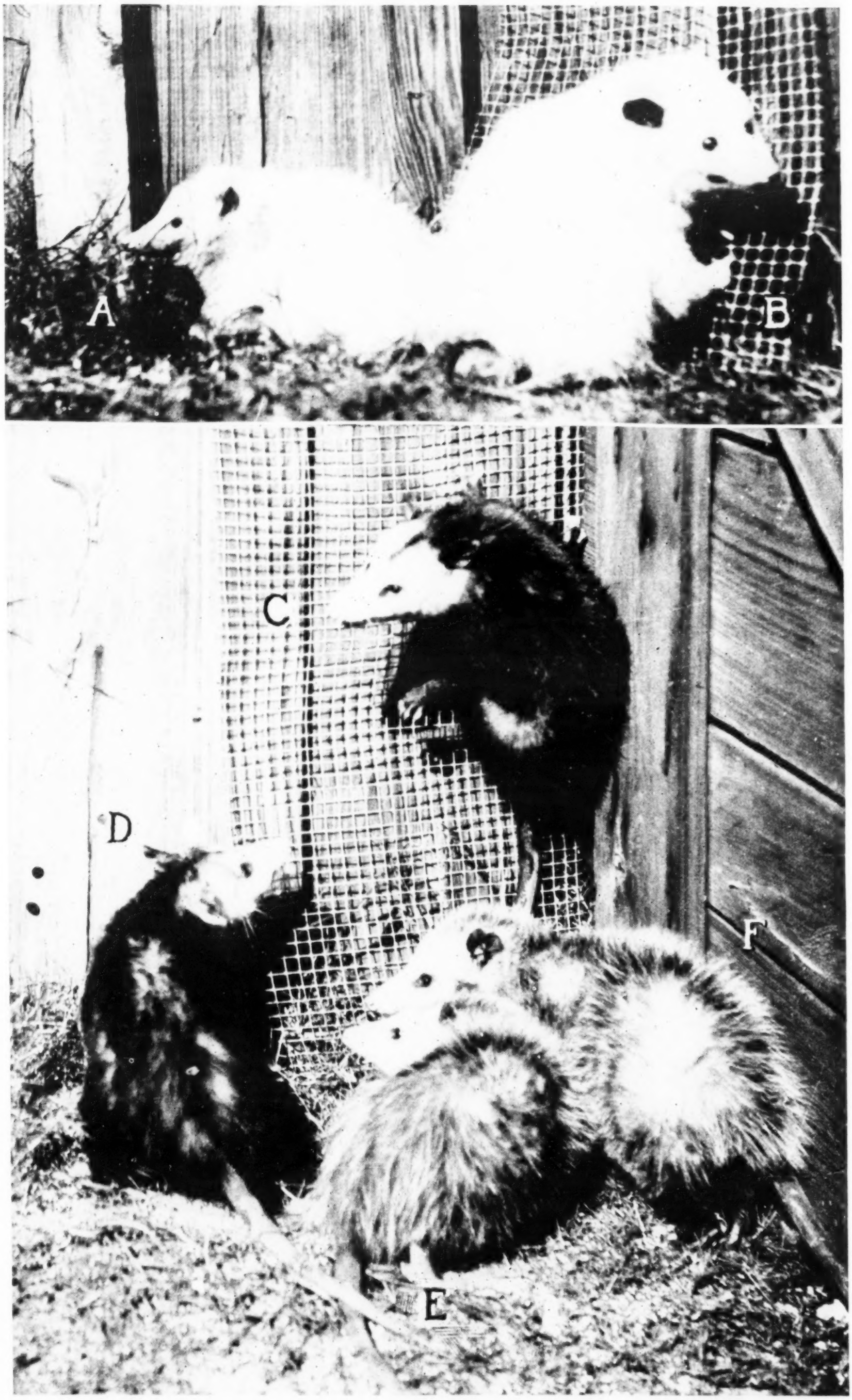
In all of the cinnamon specimens the ears and iris are also brown. This variety has been reported to the Journal of Mammalogy.

The specimens here presented would appear to make excellent genetic material and the appropriate crosses have been planned. Five types are shown, viz.:

1. Gray: black pigment in underfur, no pigment in overhair.
2. Black: black pigment in both kinds of hair.
3. Cinnamon, with brown pigment in underfur, no pigment in overhair.
4. Cinnamon, with brown pigment in both kinds of hair.
5. White: no pigment in either kind of hair.

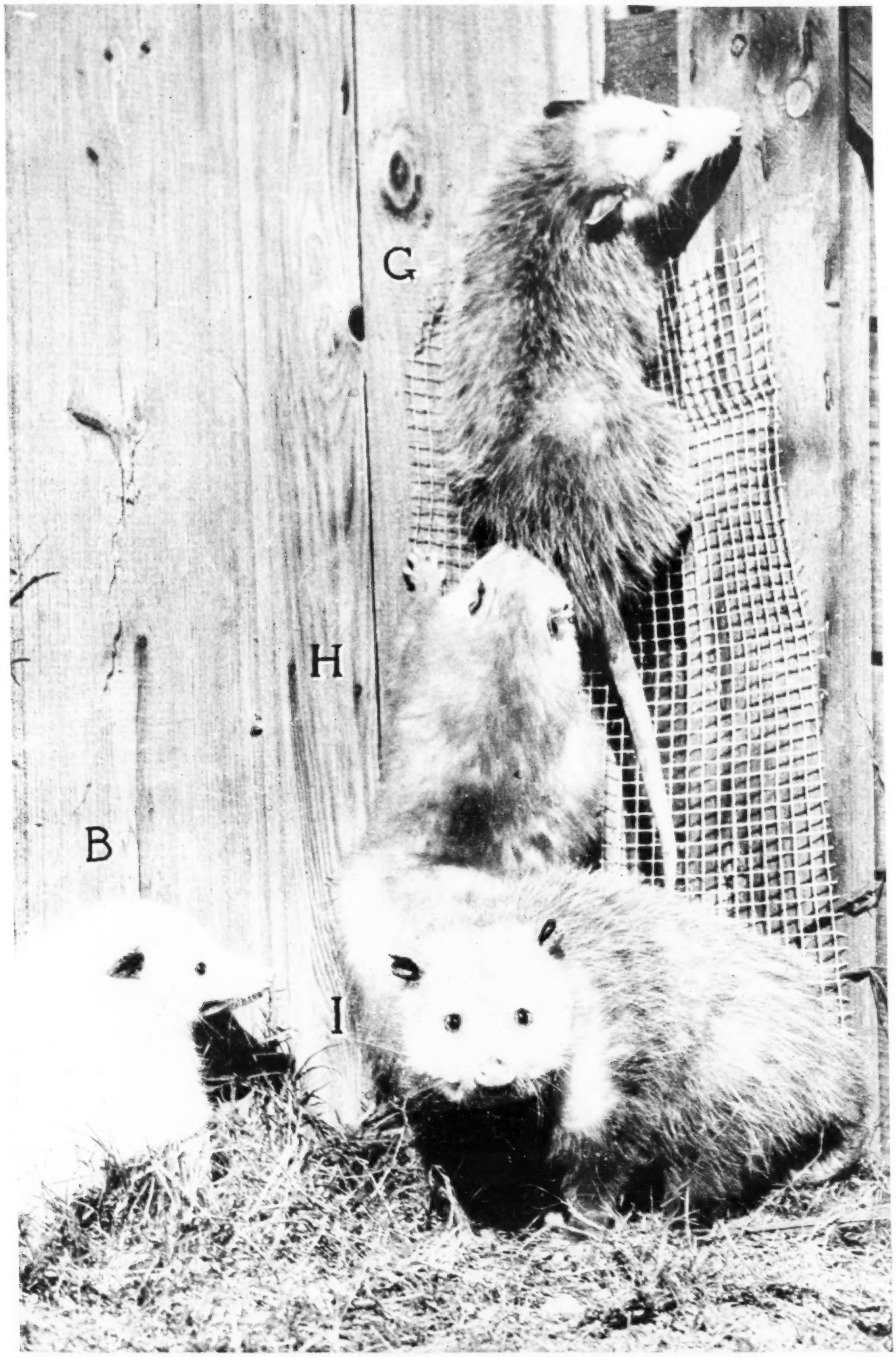
Three pairs of factors seem to be involved, (1) black versus brown, (2) pigmented overhair versus white overhair, (3) hair color versus white hair.

[1] Contributions from the Zoological Laboratory, the University of Texas, No. 157.



VARIETIES OF THE VIRGINIA OPOSSUM

The two gray animals in the lower right-hand corner (E and F) are representatives of the common Virginia Opossum. C and D are black (the black phase of D. *virginiana*). There are few or no white overhairs in such individuals and they appear to be genetically distinct from the gray. The two animals at the top are albinos. Photos by J. P. Scott and J. M. Kuehne. (Fig. 18.)



THE BROWN OR "CINNAMON" VARIETY OF OPOSSUMS

These animals came from Missouri where they are said to be not uncommon; G and H are females and I is a male. Appropriate crosses have been planned between the five types of individuals shown in the two photographs. G and I have white overhair. H is a female with brown pigment in both underfur and overhair. Photo by Carl Hartman. (Fig. 19.)

HEREDITY DENIED BY BUDDHISTS

Effects of Negative Selection in Oriental Countries

O. F. Cook
Bureau Plant Industry U. S. Department of Agriculture

AN IMPORTANT eugenic principle was stated by Dr. Alexander Graham Bell in the JOURNAL OF HEREDITY for November, 1920, under the title "Is Race Suicide Possible?" No doubt there is more to be learned before we shall have a full understanding of the reactions of "negative selection" as Dr. Bell calls it—"A selection that produces the very opposite of that expected." But Dr. Bell has pointed to some of the effects of this adverse tendency, as it works on the human race, and at the same time has urged a clearer recognition of one of the basic needs in eugenic reform, overlooked by many professing eugenists—the need of enlisting the interest of all forward-minded people in the biological facts of heredity, and in the study of such facts in their relations to human welfare. The practical objects of eugenics are to be gained, if at all, by establishing more normal, biological ideals of life and responsibility in place of the artificial or superstitious notions that so often have turned aside the course of development in the past, even among the most advanced nations.

The negative side of eugenics, as a way of escaping diseases and defects, is interesting to students of special pathological problems, but not inspiring or even attractive to the public at large. Secondary measures for restricting the multiplication of abnormal people may be developed to avoid the difficulty and expense of caring for large numbers of defectives and criminals, but the real foundation of eugenics must be built in the consciousness of intelligent, right-minded people. Of all the impediments and setbacks in human progress, the misguided self-sacrifices of those who have generous intentions for humanity and sensitive feelings of personal responsibility are the most to be regretted.

OVER-POPULATION THE ORIENTAL PROBLEM

Biology is a new science, not only in the sense of discovering new facts, but in reaching new points of view. Not only does the history of European peoples abound in examples of such "negative selection" as Dr. Bell describes, but the same principle is illustrated on a tremendous scale among the crowded populations of the Far East. The fact is most significant that celibacy has been preached for the longest time and most extensively practiced in those countries that nevertheless have developed the largest and most congested populations, to an extent that the rest of the world feels menaced by an "Oriental Problem." Two-thirds of the human race live in the Orient and are dominated by primitive beliefs that conflict, both in theory and in practice, with modern ideas of heredity.

The masses of oriental population are not affected by the "higher tenets" of Buddhism, that call for complete renunciation of life. The primitive "nature religions of Asia" have survived, with their worship of fecundity and requirement of male children to perform ancestral rites, while Buddhism has decayed in spite of its lofty ideal and all-embracing sympathy. The Buddhist theory of salvation by race suicide did not work out in the way that was expected. The history of Buddhism may be an answer to Dr. Bell's question, "Is Race Suicide Possible?"

HEREDITY VERSUS TRANSMIGRATION

To those who are following the progress of genetics, or the modern scientific study of heredity in plants and animals, it may be of interest to know that heredity is challenged as a fact and that even the idea of heredity dismissed as a delusion, by exponents of a great Oriental religion. A conflict is seen between the modern ideas of heredity and the ancient belief in the transmigration of souls, which is the foundation of the Buddhist philosophy of escape from the world of sense. The idea of the soul passing through many successive births, from one stage of creation to another, has at least a superficial similarity to evolution, but the Hindoo idea of birth is different from ours. The infant child, or even the young animal, is not a new creature derived from its parents, but a "soul" that has passed already through innumerable existences, and is now entering another, determined by its merits in the previous stages. The idea of heredity, of a new creature combining hereditary characteristics of the parental families, is not consistent with the belief in "lasting individuality of the soul," through the endless stages of transmigration imagined by Buddhists.

A REVIEW OF BUDDHIST BELIEF

With the belief in transmigration accepted as a fact the whole background of human existence is changed, and all of our usual reckonings reversed. For the genuine Buddhist, life is not a blessing to be prized and developed but a grievous burden to be escaped at any cost, even to a complete negation of all the "values" that we recognize as motives of investigation and progress. It is interesting to follow this complete divergence of Buddhist thought that leads to a denial of the facts of heredity, and seeks an end to "birth-renewal" as the highest good, and ultimate goal of human endeavor.

"*What is Sansara?*

Sansara is the world we live in, the world of illusion, error, guilt, and sorrow, of birth and decay, of endless change, disappointment and pain, of the never-ending circle of transmigration from which no escape is possible until the redeeming light of true knowledge has dawned upon us."

"*What is the cause of sorrow, and of death and birth-renewal?*

The will or desire to live (tanha), inherent in every one of us, the craving for individual existence either in this world or another (Heaven, Paradise)."

"*How can sorrow, death, and birth-renewal be overcome?*

By a free renunciation of the lust of life; by a killing out of the craving for individual rxistence either in this world or another. Therein lies deliverance this is the way to eternal peace."

"*But what is it prevents us from giving up this desire of life and from attaining deliverance?*

Our being ignorant, that is, our want of true knowledge, our want of insight into the real nature of things (avidya)."

"This, brethren, is the grand truth concerning the riddance from suffering:

It is the extinction of the lust of life, of the craving for existence: this must be overcome, get rid of, rooted out utterly."

"He who keeps in the path of true holiness, will safely cross this dreary ocean of life, and reach the heaven of eternal peace, where all suffering and all birth-renewal is at an end."

"*What is Nirvana?*

It is a condition of heart and mind in which every earthly craving is extinct; it is the cessation of every passion and desire, of every feeling of ill-will, fear, and sorrow."

"*Is every one able to reach Nirvana in this present life?*

Only the few can do so. Most men, in consequence of their acts in former lives, are morally and mentally so deficient that a great many rebirths or reincarnations are required to purify them ere they can attain deliverance. But whoever is in earnest may be reborn under more favorable circumstances."

"*Is man's birth-renewal only on this earth?*

No; there are countless multitudes of other worlds moving in space, which

are people with beings superior or inferior to man. In every one of these spheres re-incarnation may take place."

"*Are there any evil deeds requiring more than one birth-renewal?*

Certainly; there are such, of which the offender must bear the penalty in a succession of re-incarnations in a lower state."

"*Are the misdeeds of the parents visited on the children–*

No, indeed; no one has to suffer for the wrongs of others; it would be contrary to the laws of eternal justice, whereby guilt and suffering are so closely interwoven that one cannot exist without the other. . . .

It is because we are like our parents in our innermost being, our individuality, that we have become their children, not the converse, as is generally believed; it is because at the moment of our re-incarnation we have greater affinity with them than with any other being, that we have taken flesh from them. Similar causes produce similar effects. The inward resemblance between parents and children must necessarily find its expression in outward form, in inclinations and aversions, circumstances and the like.

The qualities of the parents are never hereditary—in other words, never can be transmitted from parent to child. Heredity is but a name, and the doctrine of Karma and re-incarnation can alone give a satisfactory explanation of the fact that parents and children have many qualities in common.

"*How long does the individuality continue to renew itself in repeated births?*

Until perfect knowledge and Nirvana is attained. Then, and not till then, is that haven of rest attained where there is no more suffering, no more death, birth-renewal, or individualism."

Most people are born again; evildoers go to the dark worlds, righteous people go to a bright state. Those who are free from all fetters and worldly desires attain Nirvana—they are never born again.

The doctrine of re-birth or re-incarnation is the most ancient and venerable truth possessed by mankind. It is that primitive religious sense of which we seem to have an innate knowledge unless prejudices and errors have been instilled in our minds from early youth.[1]

MENTAL ABSTRACTION OF THE HINDOOS

How a primitive people might develop the idea of transmigration is not difficult to understand. From the general belief of savages that the soul wanders away from the body in dreams and comes back again, it is only one step to the belief that should wander after death and enter the bodies of the next children that are born to the tribe. The savages may be interested only to the extent of recognizing dead friends or enemies in their children, but with the Hindoos the idea of transmigration became a fantastic, overwhelming obsession. The oppression of the belief in endless rebirths is what the Buddhist hopes to escape, through celibacy and denial of human ties. An utter indifference to all human interest is the Hindoo's ideal of perfection, which he sacrifices everything to attain. He looks on human existence as a field of punishment, and the world of living creatures as a purgatory where the souls of dead men are passing through endless processes of retribution, working out through "laws of eternal justice," toward new births in human form, with the idea of complete detachment of the "soul" the only hope of escape. It is little enough that the Buddhist hopes for, but anything is better than the nightmare world of the primitive Hindoo beliefs. According to Buddhists,

"The soul, disentangled from all that exists, finds itself alone without any object it can adhere to; folding itself up into its own being, it remains in a state of internal contemplation, desti-

[1] Extracted with slight rearrangement of paragraphs from "A Buddhist Catechism . . . for the Use of Europeans," by Subhádra Bhikshu, New York, 1920.

tute alike of all active feelings of pleasure and pain.'"[2]

Thus the Buddhist ideal is utterly remote, at the opposite pole of thought from the eugenic ideal voiced by Goethe: "To live that nobler souls come after, highest aim that man has sought."

BELIEF IN REINCARNATION A DENIAL OF PARENTAL RESPONSIBILITY

No doubt it becomes easier to apply the Buddhist doctrine of suppressing family instincts, for those who can persuade themselves that heredity is "but a name." Ties of birth and blood can have no such meaning as for us, among those who look upon their children as products of "reincarnation," with no transmission of parental qualities. It is difficult to see how any sense of eugenic responsibility could develop under the Buddhist belief that defective or diseased children are suffering necessary penalties of misdeeds in former lives.

The family ties have held, of course, with the masses of the population, notwithstanding the intellectual supremacy of Buddhism, and its persistent influence, leading thousands of the more capable members of each generation to seek "salvation" through self-elimination. Though Buddhists revolted at first against the idea of caste, it is easy to understand that the doctrine of transmigration, denial of family relationships and withdrawal from human interests, as accepted and enjoined by Buddhists, might intensify the spirit of aloofness, and thus contribute to the extreme development of caste among the Hindoos.

"We doubt if any European ever fully realizes how great the mental effect of the segrativeness, the separation into atoms, of Indian society, continued, as it has been, for three thousand unbroken years, has actually been. We speak of that society as 'divided into castes,' but it is, and has always been, divided into far more minute divisions or crystals, each in a way complete, but each absolutely separated from its neighbor by rules, laws, prejudices, traditions, and principles of ceremonial purity, which in the aggregate, form impassable lines of demarcation. It is not the European to whom the Indian will not reveal himself, but mankind, outside of a circle usually wonderfully small, and often a single family, from whom he mentally retreats. His first preoccupation in life is to keep his 'caste,' his separateness, his ceremonial purity, from any contact with any other equally separate crystal; and in that preoccupation, permanent and all-absorbing for thousands of years, he has learned to shroud his inner mind, till in revealing it he feels as if he were revealing some shrine which it is blasphemy to open, as if he had earned from Heaven the misfortune he thinks sure to follow."[3]

Some writers have interpreted the Hindoo religiosity as a great national virtue, and others as a racial defect or limitation, that kept the Oriental philosophers wandering in the desert of speculation, away from the field of science. Max Müller would set the Hindoos on a high pinnacle of contemplative virtue, while others see the Hindoo mind as self-imprisoned in a structure of elaborate but futile ideas, dreaming, at once fantastic and futile.

"The southern Aryans were absorbed in the struggles of thought: their past is the problem of creation, their future the problem of existence, and the present, which ought to be the solution of both, seems never to have attracted their attention, or called forth their energies. There never was a nation believing so firmly in another world, and so little concerned about this. Their condition on earth was to them a problem; their real and eternal life a simple fact. . . . * * * The only sphere in which the Indian mind finds itself at liberty to act, to create, and to worship is the sphere of religion and philosophy, and nowhere have religious and metaphysical ideas struck root so deeply in the mind of a nation as in India. History supplies no second

[2] Bigandet, P., 1911. The Life or Legend of Gaudama, 1:127.
[3] Meredith Townsend, "Asia and Europe," 1901, p. 153.

instance where the inward life of the soul has so completely absorbed all the other faculties of a people."[4] In utter contrast with this view is that of a recent writer who sees the Hindoo mind imprisoned in a world of elaborate dreaming, at once fantastic and futile.

"Indeed, what we have called the Hindu philosophy is more than a philosophy; it is a racial tendency and profound mental bias, and its dominating influence is, as has been already pointed out, written across the whole page of Indian history. For there is this that is sinister about the Eastern contemplative philosophy, that it cuts away the ground from under the feet of all natural knowledge of whatever kind. India's only teachers, her only professors are those solitary dreamers who remote from books and all the paraphernalia of research, commune with the infinite in their own souls. India has built up no edifice of mundane knowledge and appears in all ages to have been totally regardless of all merely intellectual achievement. She is not interested in the world we live in, and knows little or nothing about its anatomy and its laws. She is not interested in man, and knows little or nothing about his history and exploits. . . .

"India, in short, has never made anything of either art or mundane knowledge because Indian philosophy from the first has met the claims of Nature with a flat negative. The first Indian seers who started the race on a spiritual career, of which the denial of material existence was an essential condition, laid the axe to the root of all art as well as all secular science of whatsoever kind."[5]

PROGRESS OF CIVILIZATION RETARDED BY HINDOO EVASION OF THE PROBLEM OF LIFE

So much for India; but the influence of Hindoo abstraction, life-weariness and asceticism may be traced much more widely, not only in oriental countries, but in Western civilization. And everywhere these tendencies are a menace, or at least an impediment in the way of progress, in turning the interest of intelligent and well-intentioned people away from the concrete, constructive problems of human life, to seek some other "salvation" in a world of abstract, speculative "thought." If the problems are difficult, the more need of facing them directly instead of seeking a "way of escape." Surely it is a strange perversion of the mind, and essentially a superstitious perversion, that leads men to turn their back on the actual "world of the senses" and give their lives to the elaboration of a world of dreams, as in denying heredity and holding to transmigration.

FACT OF HEREDITY A DIRECT CAUSE OF EMANCIPATION OF WOMEN

Another time-honored Oriental belief that gives way before modern knowledge of heredity is that of generation as a male function exclusively, an idea that explains why descent came to be reckoned exclusively in the male line. Likeness of children to mothers was explained by "prenatal influence," not by inheritance as from the father. This theory or superstition undoubtedly contributed to the subordination of women among the Oriental nations, as well as among the Mediterranean peoples. The emancipation of woman comes as a natural consequence of our modern scientific knowledge of the fact that the mother is an equal parent of the child.

RELIGIOUS FANATICISM AND THE ORIENTAL PROBLEM

Release of the Oriental nations from the limitations imposed by their native systems of government and religious belief is a momentous change, and to many students and statesmen appears to threaten the very existence of Western civilization. Instead of "The Commercial Prize of the Orient," "The Rising Tide of Color" is now in the bookstores. The commercial European nations, after forcing themselves

[4] Müller, Thoughts on Life and Religion, pp. 77-78.
[5] Phillipps, Lisle M. Form and Colour, p. 104-105, 1915.

through the barriers of Oriental exclusiveness, are alarmed by the "pressure of population" that begins to pour out, much as the poor fisherman of *The Arabian Nights* was terrified by the genii that came out of the bottle picked up on the seashore.

Exclusion of Asiatic immigrants from a few countries is no solution of the general Oriental problem. If the reproductive pressure of the Orient is to continue even for a few centuries, it is clear that the world must be Orientalized, simply by natural increase. Control of the Orient by the European nations results in a more rapid increase of population than under the less efficient native systems of government. The real danger is not that of immediate military aggression from Japan or other oriental countries, but the gradual, peaceable, passive extension of the oriental races, who have developed and adapted themselves to a kind of existence that enables them to undermine and destroy other forms of civilization, and destroy or absorb other races.

Hence it is a problem of heredity, or at least of biology, to recognize, explain, and if possible to find means of controlling this Oriental over-production. The point raised by Dr. Bell obviously is important, and may prove fundamental. If Dr. Bell's argument is well founded, and it is true that a failure of the more capable elements of a race to leave posterity tends to an excessive production of the less capable, it may be easier to understand the present conditions in Asia, and the problems that the Oriental contacts are now forcing upon the Western nations. If Dr. Bell is right, the overpopulation, poverty, degeneration and misery of the oriental countries may be traced to the Buddhist doctrines that tend to race-suicide among the superior elements of the oriental nations, and to excessive multiplication of the less capable.

GENERAL INFLUENCE OF HEREDITY

Knowledge of heredity may have epoch-making importance in its reaction upon the human mind, quite apart from any applications of heredity in breeding and eugenics. The value of science in liberating the mind is second only to the utility of direct applications, and sometimes the indirect results are the more important. Nothing was changed directly by proving that the earth moves with the other planets around the sun, instead of being the center of the celestial system, but the progress of astronomy had an enormous effect in stimulating the general advancement of learning. Science has been described as "common sense," but this is misleading. Science is not the common sense of generally accepted opinion, but has for its primary object the study of new facts, that have not figured in the common sense of accepted opinion—facts that are "scientific" because they increase knowledge. After the new facts are recognized and assimilated into the body of knowledge, the common sense is changed, because people do not consciously and intentionally disregard facts. Beliefs are held easily against doubts, or contrary opinions but not against ascertained facts.

KNOWLEDGE OF HEREDITY LEADS TO APPRECIATION OF INDIVIDUAL RESPONSIBILITY

The facts of heredity, when they are sufficiently known, must have a very profound influence, by making it impossible for well-intentioned, high-minded people to be hypnotized by superstitious ideas, and made insensible to primary considerations of human welfare. It is the suicide of the mind that causes suicide of the body, and leads to the "race-suicide" of those who are made to believe that some other interest is more important, some action more righteous, some duty more exigent, than marrying the right wife and raising the right children. As Dr. Bell has told us, this kind of high-motive race-suicide defeats its own purpose, in ways that the high-minded people have not taken into account. To exalt celibacy is to debase woman by seeing her as a snare of evil instead of

an equal partner in the highest responsibility of life. Chastity is a virtue of high ideals of life, and of loyalty to our unfound mates and our unborn children, but celibacy as a doctrine of life is based on a perversion of ideas, and often of instincts as well. The fallacy is proven by the result that celibacy works the wrong way in relation to the world's history, not for human progress, but toward degeneration of the race.

The calamity that Roosevelt recognized and deplored as race suicide was the failure of so many well-to-do and capable people to marry and raise families. The term race suicide may be somewhat misleading, since deterioration of quality is a more serious danger than numerical reduction, but the essential fact should not be obscured, that a process of negative selection is going on, to the detriment of the race, and that the population of a country may go on increasing, as in the Orient, while the quality of the race and the conditions of existence may decline, until a limit of disaster is reached. The causes of some forms of negative selection may be found in the artificial beliefs or misvaluations that lead the capable people to sacrifice their family instincts to some idea, interest, or activity that is supposed to be more important.

It is evident from this dangerous tendency that people need to be racially right-minded as well as capable and dutiful in individual relations. Moreover, it is becoming apparent that this biological, eugenic right-mindedness is not being advanced by our over-developed system of education, which tends strongly to sterility, not through any direct teaching of celibacy as an ideal of existence, but by deferring marriage and making the educational responsibilities of parents appear too heavy for prudent people to undertake. Though celibacy is not taught as a religious motive or philosophical ideal, the effect is the same, to reduce and eliminate the more capable stocks and leave the less capable to "replenish the earth." "In New England a century has witnessed the passage of a many-child family to a one-child family. The purest New England stock is not holding its own. The next stage is the no-child marriage and the extinction of the stock which laid the foundations of the republican institutions of this country."

COLOR OF CROSS BRED CALVES

What will be the color and form of a cross bred calf of the Jersey and Holstein breeds? We have notes on six such calves. Five of the calves were sired by our Holstein herd bull that is half black and white. The first calf was out of a high grade Jersey cow, a fawn in color. The calf was a solid black. The second calf was out of a grayish cow, a high grade Jersey, and the calf was solid black. The third calf was out of a pure bred Jersey cow of yellow fawn, and the calf was marked like a Holstein. It was half white and black. The fourth calf was out of a fawn cow, grade Jersey, and the calf was black on the body with white legs. All of the grade Jersey cows were almost pure bred, and had no Holstein blood in them. The fifth calf is out of a pure bred Jersey cow that is a reddish fawn and the calf is half white and black like a Holstein. A grade Holstein cow that is black, mated with a Jersey bull produced a solid black calf.

Thus it seems that the Jersey color is entirely recessive to the Holstein color as the fawn did not appear in the calves from Jersey cows and a Holstein bull, nor from the reciprocal cross of a grade Holstein cow and a Jersey bull. Half of these calves were solid black, one had a black body and white legs and two were marked like a Holstein, white and black.—*J. J. Hooper, University of Kentucky.*

The American Genetic Association

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Annual dues, giving the right to attend all meetings, and receive the JOURNAL OF HEREDITY, are $3 within the United States and its possessions; $3.25 in Canada, and $3.50 in all other foreign countries; life membership, $50.

If you are not already a member, and want to become one, or if you know of anyone who you think is interested in membership, write to

THE AMERICAN GENETIC ASSOCIATION

Menasha, Wisconsin

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